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OFFICIAL PUBLICATION OF IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS

REPORT OF

PRACTITIONERS' SHORT COURSE IN

VETERINARY MEDICINE

VOL. III. NO. 1

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AND MECHANIC ARTS

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PRACTITIONERS' SHORT COURSE

I. S. C. of A. & M. A.

Vol. III. No. 1

DIVISION OF VETERINARY MEDICINE

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INTRODUCTION.

The contents of this bulletin was presented at a Practitioners' Short Course September 4-9, 1916, but it was thought best to publish it as an independent report. On account of unavoidable conditions resulting from the war the publication has been delayed until the present time. During the meantime the material has been somewhat revised and brought up to date.

It is estimated by the United States Department of Agriculture that animal parasites are responsible for annual losses aggregating five million dollars. This loss could be greatly reduced if more determined efforts were made to control or eradicate the common parasites of domesticated animals instead of accepting them as a matter of course. It is a well known fact that many farmers have been compelled to discontinue sheep husbandry because animal parasites rendered the business unprofitable or even a source of loss. There is a very large animal loss in Iowa each year as a result of infestation of young horses with sclerostoma. The loss results not only from death of many animals when infestation is extensive but the loss of condition as well as predisposition to other diseases is an important factor frequently lost sight of.

I trust this Bulletin will assist the veterinarians in handling the problems due to different forms of intestinal parasitism in their respective communities more efficiently.

C. H. STANGE,
Dean and Director.

ASCARIASIS AND OESOPHAGOSTOMIASIS.

By W. W. Dimock, Ames, Iowa.

ASCARIS (Ascariasis)

1. Ascaridae are among the largest of the round worms (Neatodes) parasitic to domestic animals, most of the species measuring several inches in length. These parasites, while being found almost exclusively in the small intestines, may be met with in the stomach, oesophagus, large intestines, and in some species of host (swine especially) in the bile ducts and liver where they occlude the bile channels and inhibit or stop the flow of bile with more or less serious results. These parasites are very common, practically every species of domestic animal harboring a species of ascaris, varying proportionately in size to that of the host. Often they are so numerous in a single host as to nearly fill the intestinal lumen over a considerable length of the bowel. These worms are whitish or yellowish white in color, and gradually taper toward the ends from near the middle of the body. The borders of the lips are generally denticulated; the males have two equal spicules and numerous papillae about the anus which constitute one of the best specific generic characters. The ova which are globular, are deposited in the intestinal canal of the host, but show no development until after their expulsion, free atmospheric conditions being necessary for their growth. Warmth and moisture are favorable to their embryonic growth yet they will resist dessication for weeks or months and maintain their vitality. The embryos form externally on the grass or damp soil but not in water. If the ova are taken in, after a certain length of external incubation, the embryos are set at liberty in the intestine of the host. Infestation occurs by the injestion of ova or larval forms of these nematodes by their specific host. An intermediate host is not necessary.

The adult form of these parasites may be recognized with more or less certainty from their large size, their characteristic round worm shape, their whitish color, their presence in the small intestine and from the fact that they are a very common parasite, being found in Iowa in from 1 to 75% of the animals examined. The percentage of animals showing infestation varies very materially from year to year in different as well as in the same section of the country.

ASCARIS MEGALOCEPHALA.

1. Definiiton: Ascaris Megalocephala is common to the small intestines of the horse, ass and mule. Its presence does not, as a rule, appreciably affect the health of the host. However, in young animals it may cause various digestive troubles, chronic

intestinal catarrh, diarrhea, obstruction of the bowel, colic and emaciation. The ova pass out with the feces, develop in moist dirt or on grass and are taken up by the host (horse) in which they develop to adult parasites in the intestine. They are frequently found in great abundance.

2. Description: *Ascaris Megalocephala.* Body yellowish-white, rigid, head distinct and has anteriorly three papillary lips, constricted in their middle, having comparatively large teeth on the free margin.

Male: Length 12-28 cm. Tail is bordered by two small membranous wings and a number of papillae 7 of which are post anal and 4 and 5 and 6 and 7 of these joined, respectively, to form one. There is a single papilla in front of the anus and other pre-anal papillae are arranged in a single, and then, in several rows. Also two cylindroid curved spicules.

Female: Length 18-37 cm. The vulva is situated in the anterior fourth of the body; anus nearly terminal; the tail cone shaped and blunt. Ova nearly globular, 90 to 100 microns in diameter. See Fig. No. 1.

3. Life History: The eggs, which are deposited by the adult female in the intestinal tract, pass out with the feces and under favorable conditions (moisture and warmth) develop into embryos. At a temperature of 37 degrees -C (98 degrees F), the ova of Ascaris megalocephala hatch after 3 to 4 days, development being hindered by water and retarded by light. There is every reason to believe that food materials and water become contaminated with ova or embryos and through its ingestion infestation takes place. Eggs have been found in the feces 10 to 12 weeks after the ova were ingested.

4. Symptoms: The presence of ascaridae in older horses does not, as a rule, affect the health of the host. In young animals it may give rise to various digestive troubles, chronic intestinal catarrh, with a mild, but obstinate diarrhea. They may, from numbers and by twisting, cause obstruction of the intestine which, in severe cases, terminates in death. Symptoms of nervous disturbances have been observed, and clinically suggest that the parasite produces a substance which, when absorbed, is toxic. Evidence of this intoxication is best seen in pigs. They are often present in the small intestines without apparently affecting the health or giving indications of their presence.

5. Lesions: At the autopsy of animals, the death of which was due, either directly or indirectly, to the action of this parasite, more or less severe intestinal congestion and even rupture are often observed. It is quite probable that the parasites at-

tack the mucous membrane of the intestine with their denticulated lips inducing inflammation and ulceration which predisposes to rupture. Signs of general anemia, intoxication and chronic inflammatory changes are often observed and evidently are the result of the absorption of poisonous products. This is further evident clinically through nervous disturbances and unthriftiness. Secondary factors often enter in and care should be taken to etiologically differentiate the lesions found upon post mortem examination of animals that have apparently died from the effects of this parasite.

6. Prevention: Since natural infestation takes place by the ingestion of contaminated food and water, prevention may be accomplished by avoiding such materials and providing uncontaminated food and water. Lands that are contaminated with material from barns in which infested horses are stabled or which have been exposed from pasturing, are not safe for pastures for at least some months as ova and embryos are very resistant and may live a long time outside the animal body. Manure from affected animals contains thousands of eggs, and the young of affected mothers are almost sure to become infested if allowed to run with such adults or in areas in which the eggs and embryos have been deposited. Feces passed naturally by the infested host, or when expelled through the action of vermifuges, should be treated with some chemical that will destroy the eggs.

ASCARIS VITULORUM.

1. Definition: *Ascaris Vitulorum (A. vituli),* or the ascaris of the calf, rare in adult animals and only occasionally present in large numbers is common in the calf and often in numbers sufficient to be injurious. It is met with in the small intestines and exceptionally in the abomasum where it produces inflammation and symptoms common to intestinal helminthaisis. There are records which report that the intestines contained as high as 15 liters of this parasite. Enzootics have been observed among calves of 10 days to 6 months old.

2. Description: *Ascaris Vitulorum.* Calf. Reddish-white in color; transparent integument when fresh; head small and distinct; lips enlarged at the base, but constricted in anterior two-thirds, the free margin of which is markedly denticulated. Posterior extremity terminates with conical point.

Male: Length 15-20 cm. Caudal papillae form two irregular lateral rows of 10-15 each, all pre-anal.

Female: Length 22-30 cm. Vulva toward anterior sixth of the body. Ova 75-80 microns.

3. Life History: This parasite is rarely met with in adult cattle and then only in small numbers. When present it apparently spreads to young calves or from one calf to another very readily. The ova pass out with the feces, segment and are taken in with food and water. Warmth and moisture hasten the development of the ova and under favorable conditions, the completion of the life cycle will perhaps take less than two months. No intermediate host is necessary as the ova or embryos are taken in directly on food and water. Pastures, yards, and barns become places of infestation to young stock.

4. Symptoms: The Ascaris vitulorum is rarely visibly, detrimental to adults, but when present in large numbers may cause enzootics of indigestion, diarrhea and enteritis. In young calves the symptoms are more evident and the effects often fatal, rupture of the bowel being not uncommon. There may be nutritive disturbances, variable appetite, pale mucous membranes, alternating constipation and diarrhea, and a peculiar penetrating smell is given off. The duration of the disease is from one to several weeks. Convalescence is slow.

5. Lesions: The calf ascaris produces no symptoms or lesions that would definitely characterize it from other helminthes. However, the parasite or its eggs are quite easily recognized in the feces, and is the only positive means of diagnosis clinically. In suspected cases vermifuges may be given to secure feces for examination for eggs, or to expel the parasite itself, thus making the diagnosis easy. The parasite produces local inflammation of the mucous membrane; gives rise to colicky symptoms and may cause rupture of the organ. The flesh of animals, harboring large numbers of this parasite, acquires a very bad odor and by many is considered to be more or less characteristic. Post mortem (by Dimock) on a calf ten days old, Province of Havana, Cuba, revealed a large number (3 liters) of fully developed ascaridae, some of them measuring 31 cm. Such cases tend to explain how the idea of congenital infestation might have been entertained by those unfamiliar with the limit of range in the life history of Ascaridae.

6. Prevention and Diagnosis: Infestation of young individuals may be prevented by separating them from the older infested animals; by expelling all ascaridae from animals in the herd; by cleaning and disinfecting barns and yards and the proper control of pastures and water supply. Feces from infected animals and those being treated should be collected and disinfected, burned or buried.

ASCARIS OVIS.

1. Definition: Ascaris ovis is one of the more rare parasites found in the intestine of sheep, only two out of fifteen post-mortems-(June-July, 16-Dimock)-from two neighboring flocks of

sheep, revealing their presence. These worms produce lesions typical of those given rise to by the related species of other hosts, but possibly in a slighter degree, since the lips are very finely denticulated, as compared to the more heavily toothed lips of other species.

They have never been found in numbers sufficient to cause any clinical evidence of their presence.

2. Description: *Ascaris Ovis.* Body a very light yellow and slightly attenuated at both ends. The head is separated from the body by a very slight constriction, which is caused by the spreading of the three lips. The superior lip has two small papillae near its base while the inferior lateral lips have only one papillae. All three lips are very finely denticulated. Cuticle very finely striated.

Male: Length 7-10 cm. The tail is curved, thus making it easy to distinguish from the female in which the tail is straight. Two lateral-ventral rows of 40-50 papillae each—three of which are post-anal. One papillae on the very tip of the tail.

Female: Length 7-12 cm. Tail ending rather obtusely but tapering out into four rather characteristic segments, the last of which is recurved dorsally.

Ova: Oval, the border being dented. See Fig. No. 2.

The life history, lesions and prevention are the same as for those of related species, particularly resembling those in cattle.

ASCARIDAE OF THE DOG.

1. Definition: Ascariasis in the dog may apparently result from the infestation of two species of ascaris. As a rule, these round worms cause very little trouble but in some instances large numbers collect in masses and cause inflammatory catarrhal disturbances; they may even cause symptoms of intestinal stenosis, and in some rare instances these parasites produce hemorrhagic furrows in the mucous membrane. Cramp and nervous disturbances, thought to be due to the absorption of poisons secreted by them, are seen in the dog. The younger animals are more often infested—puppies under 6 months of age. Vomiting is the usual clinical evidence of their presence.

2. Description: *Ascaris Mystax. Canis.* Body white or reddish; head usually curved and provided with two lateral membraneous wings, broader behind than in front causing it to be arrow-shaped. These membranous flaps are situated more dorsally than in the corresponding species of the cat, and are not quite so prominent. The body is slightly wider and longer than that found in the cat; is very irregular and twisted, and is not of the typical S shape of the Felis species; prominent lips,

non-denticulated, which are rather widely separated, each lip having a large papillae.

Male: Length 5-10 cm. Tail curved and ending in a rather crooked point; 26 papillae on each side, 5 of which are post anal.

Female: Length 9-14 cm. Tail obtuse, ending in a blunt point which is surrounded by 6 membraneous saeta. Vulva toward anterior quarter of the body. Ova nearly globular, 75-80 microns. See Fig. No 3.

3. Life History: Young dogs, a few days to a few weeks of age, may become infested with ascaris, but they become most abundant at about 2-3 months. The ova are voided with the feces and in the presence of moisture and warmth, develop in dirt or straw. They are very resistant to desiccation and unfavorable conditions, living a long time outside the host. This is a very important matter in prophylactic treatment. At a certain developmental state they are ready to be taken into the host, and upon reaching the intestine by way of the mouth, on food or water, they soon reach the adult stage, copulate in the lumen of the gut and reproduce. Data compiled seems to show that no intermediate host is necessary for the completion of the life cycle of this ascaris.

4. Symptoms: Symptoms of ascariasis in dogs are particularly noticed in young animals although they may be seen in adults. Ascaridae produce emaciation, unthrifty condition, rough coat, enlarged abdomen, irregular appetite, colics, and constipation or diarrhea. In masses they may arrest the course of the alimentary content or cause complete obstruction inducing invagination and death unless surgical relief is given.

5. Lesions: Aside from the changes mentioned under symptoms the following are found on autopsy: the intestinal mucous membrane is often tumefied and catarrhal; shows numerous small round black points in the center of which are ulcerous depressions; intense hemorrhagic enteritis with fissures and excavations having ulcerated borders, the latter process involving all coats of the intestine. It is probable that the ulcerative processes are very largely the result of microbian infection. Definite diagnosis is assured only when the parasites or ova are found and identified.

6. Prevention and Treatment: Dogs to be treated must be kept in entirely clean quarters and provided with clean food and water. Feces of infested dogs are always dangerous and must de disposed of with special precaution.

Among those worms which have been examined here we find an ascaris which does not possess the membranous flaps, or wings, and which is smaller than the true A. mystax. The two species of the cat and dog are supposed to be the same

and are called the A. mystax of the cat and the A. marginata for the species found in the dog. The finding of this worm, which does not possess the character of the mystax species leads us to classify it as a true Ascaris marginata and to suggest that the mystax of the dog and cat be designated as Ascaris mystax Canis and Ascaris mystax Felis.

Ascaris Marginata: Canis. Body white to yellow-grey, curved to form a U with the head and tail recurved so as to point outward. Head nude; three non-denticulated lips with a papilla central in position; cuticle rather thick and heavily striated.

Male: Length 4-7 cm.

Female: Length 5-9 cm. Tail curved in opposite direction from that of the head; rather obtuse, ending in a sharp point. Anal opening prominent.

Ova: Oval with rather flat, depressed sides. See Fig. No. 3.

So far as known the life history, as well as the symptoms and lesions are the same as in case of Ascaris mystax Canis.

ASCARIS MYSTAX *(Felis).*

Like the corresponding species in the dog, this ascaris is found more frequently in young cats, but it is not at all rare in the older animals. In those under three years it has been found in certain sections to be present in at least 50% of the cases upon which post mortems were held. They are seldom present in large numbers—from 10-12 but, at times, may be found in numbers sufficient to cause disturbances such as nausea, vomiting, loss of weight and an insatiable appetite.

1. Description: *Ascaris Mystax. Felis.* Body is usually white, sometimes slightly tinged with red; head is curved, and provided with two membranous lateral wings, broader behind than in front, which gives it the appearance of an arrow head. Each of the three lips has a rather prominent papilla. Body curved in an S shape and is very rigid.

Male: Length 5-10 cm. Tail recurved to point in opposite direction from that of the head. 26 papillae on each side, 5 of which are post anal.

Female: Length 9-12 cm. The tail is rather straight and slightly obtuse; vulva situated toward the anterior quarter of the body. Ova, nearly round, 75-80 microns in diameter. See Fig. No. 4.

The life history, lesions, and prevention are the same as for those of the closely related species found in the dog.

ASCARIS SUILLA.

1. Definition: The Ascaris suilla apparently finds in the small intestine of the pig conditions most favorable for its propa-

gation, but it may be found in the stomach and not uncommonly (1-2% of the pigs in Iowa) invades the common bile duct, gall bladder, and bile ducts of the liver. It is very common and frequently in numbers sufficient to cause general intestinal disturbance and obstruction. Their presence will cause the host to become emaciated, inducing cough and restlessness with symptoms of colicky pains; also intoxication followed by nervous disturbance. When it invades the gall ducts, or pancreatic ducts serious hapatic diseases result; stupor, giddiness and often jaundice.

2. Description: *Ascaris Suilla.* Body milky white or reddish; firm, elastic and marked by longitudinal striae which are close together. Attenuated at both ends. The head is small; mouth terminal and triangular; the lips are denticulated, the upper having a papilla at each of its inferior angles, the other two having only one situated at the middle of their bases.

Male: Length 15-17 cm. and about 3 mm. thick; 68-75 papillae at its caudal end, seven of which are post anal. Spicules are flat and blunt.

Female: Length 20-30 cm. and about 5 mm. thick. The vulva is situated toward the anterior third of the body in the middle of an annular constriction. Uterus small and doubled; ova 66 microns long and shell having small depressions or pits. See Fig. No. 5.

3. Life History: The eggs laid by the adult female, pass out with the feces, and in the presence of moisture and warmth, go thru certain developing changes. In a few days, or weeks, they are ready to be taken back into the digestive tract of the pig, either in the form of embryos or ova. Again in the digestive tract, they develop rapidly to maturity. As in the case with other ascaridae a part of the life cycle must be passed outside of the host. No intermediate host is necessary, in fact only certain elemental conditions and time for developmental changes seem to be essential to prepare the ova and embryos for the host.

4. Symptoms: Symptoms of ascariasis are more marked in young pigs than in adult animals and are almost always evident clinically if the infestation is at all severe. Cough, restlessness, weakness, debility, diarrhea and emaciation are to be looked upon with suspicion. Animals badly affected are stunted, pot bellied and develop a weakness, especially noticeable in the hind legs, which closely resembles form of paralysis or the wabbly weaving gait so often shown in cases of chronic hog cholera. Their appetite is ravenous and depraved. They will hastily come to the feed trough and start to eat ravenously but will suddenly stop and soon walk away, thus seemingly able to eat but little. (Lack capacity). As the disease becomes more chronic the affected animal becomes thin and leggy, abdomen bloated and the coat rough

and staring. The parasite invades the bile duct, gall bladder and bile passages of the liver causing stenosis or obstruction of the bile ducts and resulting in serious hepatic disturbances,—jaundice and death.

5. Lesions: In animals that have died from the effect of this parasite or that have been killed when showing advanced clinical symptoms, the following tissue changes are found.

In the intestinal tract congestion and inflammation may be mild or severe. The mucosa is, no doubt, injured by the parasite and its toxic products, but the more severe lesions, degeneration, ulceration and necrosis, are no doubt the result of bacterial infection. Loss of condition and emaciation are due to the altered condition of intestinal content; to the interference with proper assimilation of food, and from the absorption of the toxic substance from the parasite. We have observed a number of herds in which the clinical evidence of intoxication was marked. Post mortem examination of such animals showed mild chronic inflammatory changes in the parenchymatous structures; the liver and kidneys. In the kidney the capsule is slightly adherent, the parenchyma showing cloudy swelling and the interstitial structures slight fibrosis. In those cases where the ascaris invade the bile duct and gall bladder jaundice is often marked. Invasion of the bile ducts of the liver gives the organ a nodular, or rigid, appearance and, if close to the surface, gives a yellow color to the distended part. These discolored areas have been mistaken for abcesses and tubercular lesions. Microorganisms carried into the liver by the parasite frequently cause suppuration and necrosis. The finding of large numbers of this parasite is diagnostic of ascariasis. In case of death in badly infested individuals and the absence of lesions characteristic of other diseases the cause of death may reasonably be attributed to the action of the parasite.

6. Prevention and Treatment: The manner of infestation is by ingestion of contaminated food or water. The infestation spreads rapidly among hogs because of the manner in which they are kept and live. A light infestation is frequently ignored but is important for, if conditions are favorable, reproduction, is rapid and subsequent generations of pigs may become seriously infested. Old hog yards and barns, that have been used continuously for a period of years, usually keep the disease in the herd and cause more serious results each year as they become more infested and no proper treatment is employed to stop the propagation of the parasite. As to prophylactic measure it may become necessary, not only to clean up old lots and pens, but to move the animals from such places and establish them in new quarters. Hog houses that can be easily cleaned and disinfected are recommended. The parasites are readily expelled by the use of the better vermifuges. However, the results will only be tem-

porary unless the premises are cleaned and disinfected in a way that will destroy all ova.

The economic importance of ascariasis in pigs is such, in Iowa as to demand our most serious attention. As a result of investigation we are forced to conclude that from one to two per cent of the pigs in this State die annually from invasion of the bile duct and liver by the ascaris suilla. On a basis of one per cent with a total number of nine million pigs in the State the loss would be 90,000 pigs that die from the action of this worm when it invades the liver and at an average valuation of four dollars ($4.00) per head would be $360,000. This does not take into account other ways in which loss is sustained from the injurious action of this parasite. For example in a litter of eleven pigs on a farm near Ames one died from invasion of the liver by this parasite. The other ten were treated to expel the worms. The eleven pigs had failed to gain in weight for thirty days previous to diagnosis of the trouble and treatment.

Death of one pig	$ 5.00
Medicine	.90
Cost of feed for 30 days, during which time there was no gain	8.00
Total loss in litter of 11 pigs	$13.90

NOTE: (Journal Agri. Research November 19, 1917.)

Recent experimental work by F. H. Stewart 1916 on the Life History of Ascaris Lumbricoides and by Ransom and Foster 1917 on the Ascaris Suilla points rather conclusively to an additional step beyond what was formerly known to be necessary for the different species of ascaris to complete their life cycle.

An intermediate host is not necessary but the findings go to show that when the eggs of the Ascaris are taken into the alimentary tract (rats, mice and pigs) they hatch and form embryos. The embryo worms migrate to the lungs and other tissues. Form the lungs in about one week they migrate up to trachea, pass out through the larynx and down the esophagus to the stomach and intestines. If in a suitable host they will develop, become mature parasites and reproduce. In the case of experimental animals (rats and mice) the parasites upon reaching the digestive tract from the lungs will not develop but soon pass out of the body.

It is believed, on the basis of these findings, that the ascaris embryos as found in the lungs, are often the cause of a serious pneumonia so frequently seen in young pigs, and are therefore far more important as parasites than was formerly known. Young pigs are far more susceptible to infestation (intestines and

lungs) than old hogs. This I believe conforms in the case of the intestines to the findings of every veterinarian who has ever held any number of post mortem examinations on swine.

ASCARIS INFLEXA.

Introduction: Ascariasis of poultry has not been given much attention in this state, but its frequency and importance demands mention. These worms (ascaris inflexa) are rather large considering the size of the intestinal lumen in which they are parasitic, and a very few of them may cause occlusion. In the more southern and western states it is often present in numbers sufficient to render profitable feeding impossible unless the fowls are first treated, the worms expelled and further reinfestation prevented.

1. Definition: Ascariasis of poultry is characterized by unthriftiness, emaciation and by those general symptoms and lesions that commonly result from ascariasis in the larger domestic animals.

2. Description: *Ascaris inflexa.* Chicken. Body white, round and firm, cuticle striated the full length of the body. Mouth, three lips possessing no teeth—oesophagus long, broader at posterior end.

Male: Length 4-6 cm. Two spicules; two spicule like structures around and back of anus. Bursa supported and attached to three pairs of prominent lateral papillae. Three pairs of smaller lateral papillae back of anus; one single papillae just in front of the end of the tail. Anal region prominent and flattened ventrally.

Female: Length 5-7 cm. Vulva in front of the middle of the body; anal opening a little in front of the caudal end. Intestine slightly coiled; four pairs of post-anal papillae; four larger pairs even with anal opening. Ova, 50-74 microns. See Fig. No. 6.

3. Life History: Its life history has not been definitely worked out except in a general way, but the results, however, tend to show that it is typical of the genus. Recent experimental work carried on in California shows that birds from which the worms have been successfully expelled will become infested within a few days or weeks if kept in contaminated quarters. The control methods, again are the same for other species, cleanliness being the most important factor in their eradication.

4. Symptoms: The symptoms of birds harboring these parasites are in general the same as those observed in other animals, loss of condition to the point of emaciation and failure to gain when on full feed. The symptoms and lesions resulting from the presence of this parasite, however, may resemble other forms of

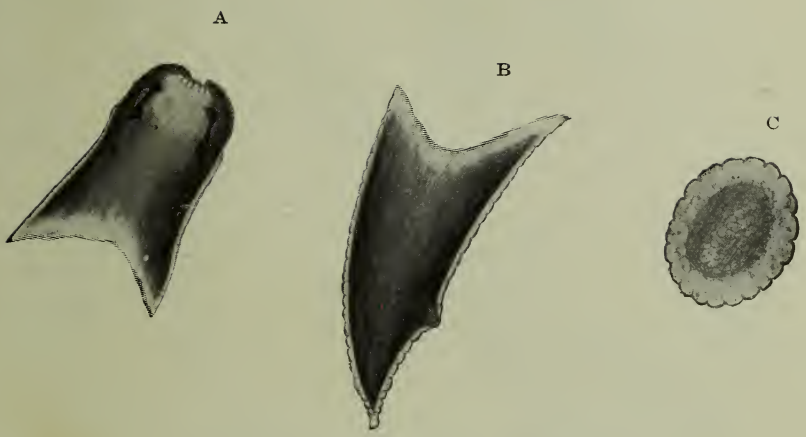

Fig. No. 1. ASCARIS MEGALOCEPHALA.

a. head.
b. caudal end of female.
c. egg.

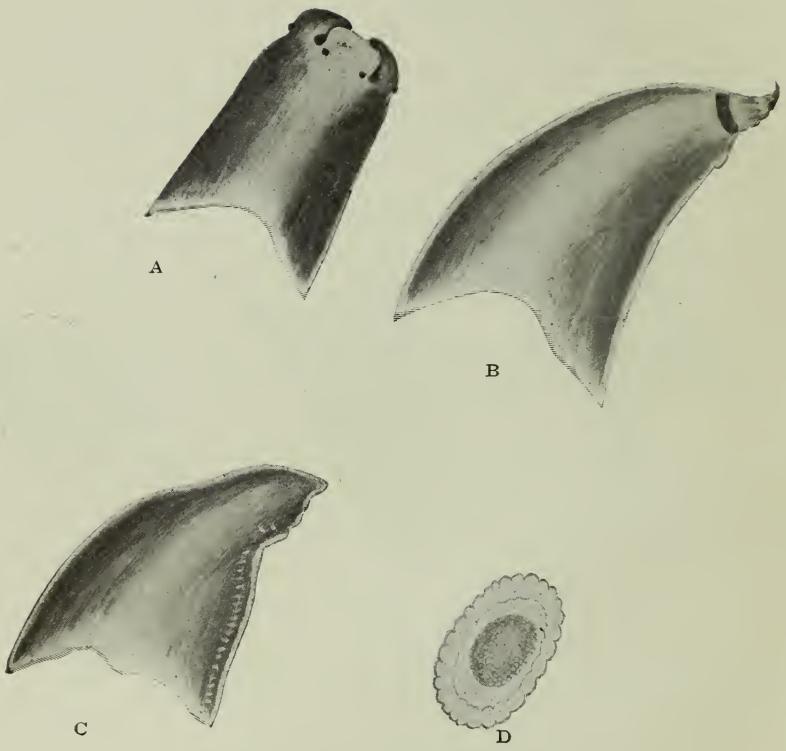

Fig. No. 2. ASCARIS OVIS.

a. head.
b. caudal end of female.
c. caudal end of male.
d. egg.

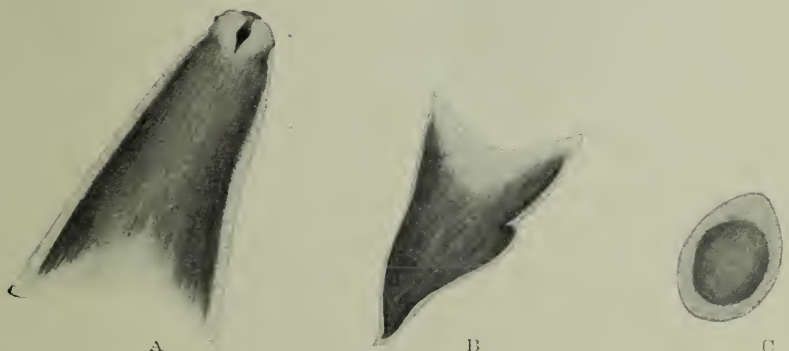

Fig. No. 3. ASCARIS MARGINATA.

a. head.
b. tail of female.
c. egg.

Fig. No. 4. ASCARIS MYSTAX (canis).

a. ventral view of head.
b. dorsal view of head.
c. tail of female.
d. tail of male.

Fig. No. 5. ASCARIS SUILLA.

a. head.
b. caudal end of male.
c. caudal end of female.
d. egg.

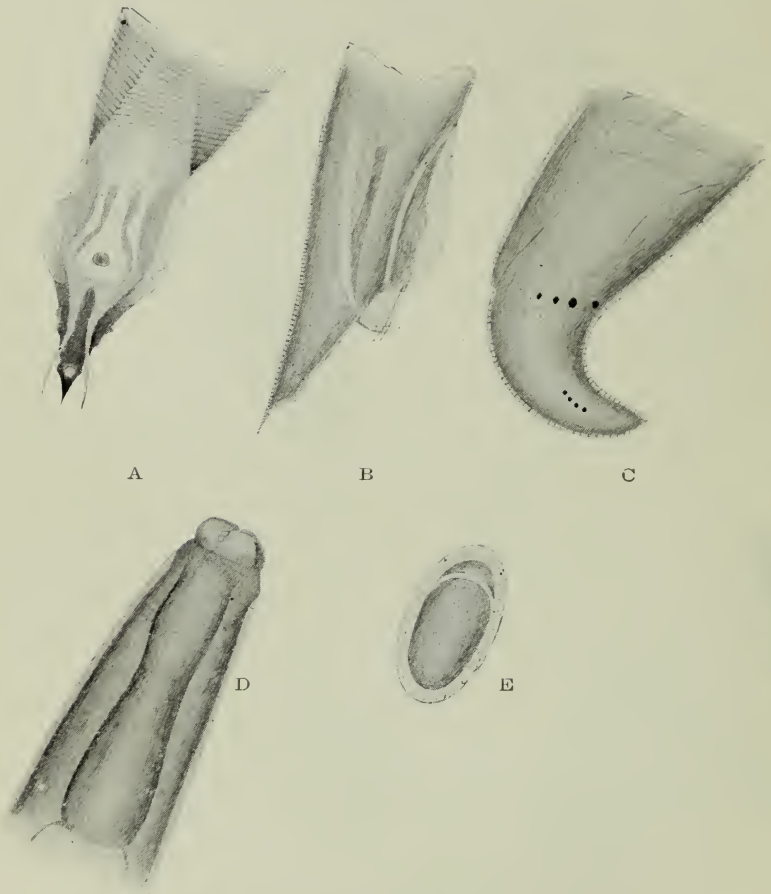

Fig. No. 6. ASCARIS INFLEXA.

a. ventral view of tail male.
b. lateral view of tail male.
c. tail of female.
d. head.
e. egg.

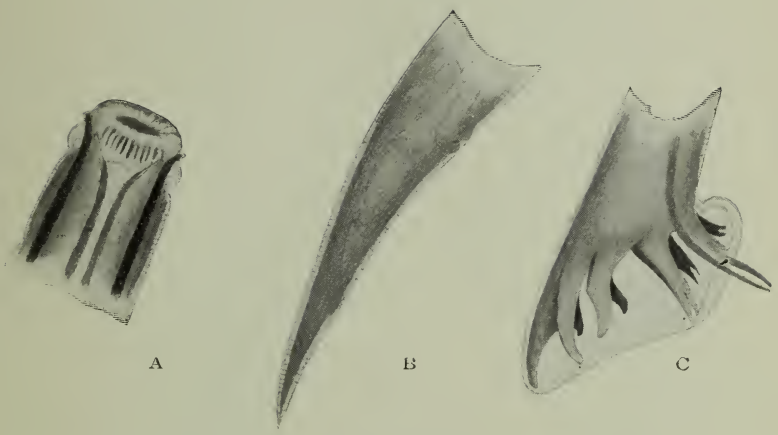

Fig. No. 7. OESOPHAGOSTOMUM COLUMBIANUM.

a. head.
b. caudal end of female.
c. caudal end of male.

Fig. No. 7a. CAUDAL END OF FEMALE (O. columbianum). Showing everted oviduct attached to a small piece of mucous which was removed with the parasite.

Fig. No. 7b. OESOPHAGOSTOMUM COLUMBIANUM. adult male and female.

A B

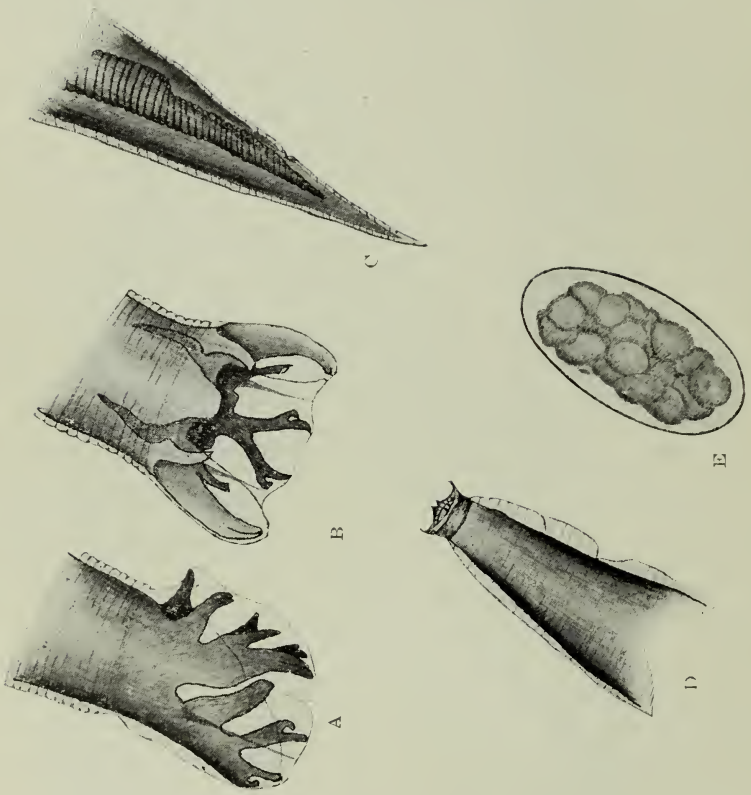

Fig. No. 8. OESOPHAGOSTOMUM EDENTATUM.

a. lateral view of tail male.
b. ventral view of tail of male.
c. tail of female.
d. head.
e. egg.

Fig. No. 9. COLON OF PIG SHOWING NODULES OF NODULAR DISEASE.

a. old nodule.
b. very young nodules, red in color, in which the young parasites can be found.

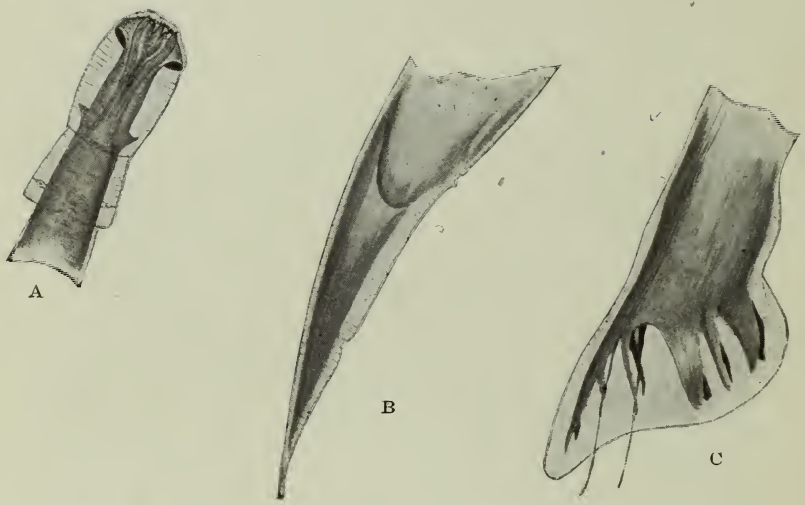

Fig. No. 10. OESOPHAGOSTOMUM radiatum.

a. head.
b. caudal end of female.
c. caudal end of male.

Fig. No. 11. MUCOUS SURFACE OF SMALL INTESTINE COW.
Showing numerous early lesions of oesophagostomiasis.

intestinal parasitisms in chickens: Taeniasis and Cheilospirosis may bring about the same general evidence of disease. This emphasizes the necessity of a positive diagnosis before suggesting methods of prevention.

5. Lesions: The lesions which are usually present in the intestinal tract when there is an invasion by this parasite, are those of congestion, inflammation and often hemorrhage, closely resembling those found in ascariasis of other hosts. Lesions in other parts sometimes met with are mild chronic inflammatory changes in the liver and kidneys; evidence of intoxication and general emaciation.

6. Prevention and Treatment: Infestation occurs from the ingestion of ova and larval forms from grounds, food and water, contaminated by the droppings of infested birds. Worms may be readily expelled by the use of vermifuges such as turpentine, tobacco, areca nut, santonin and calomel. Reinfestation will occur unless the voided ova are destroyed.

Of prime importance in the prevention of ascariasis in fowls is:

1st. The successful treatment of all infested individuals.

2nd. Destruction of ova by proper disinfection of all droppings and contaminated runs.

3rd. Do not permit birds to drink surface water.

4th. Furnish well water and in receptacles that cannot become contaminated from droppings or by the birds stepping in the dish.

5th. Place all food in feeding crates that birds cannot step in or soil with droppings.

OESOPHAGOSTOMIASIS OR NODULAR DISEASE.

Introduction: Although nodular disease of sheep, swine and cattle has been recognized for years, however, many points regarding the nature and importance of the disease and the life history of the parasites are not well understood. Our lack of definite knowledge regarding the parasite renders us unable to carry out any practical and effective preventive measure. Experience gained from post morten examination would indicate that this is a serious disease in the above species of animals. There is every reason to believe that Oesophagostomiasis is of economic importance over a greater area in the United States than is generally known.

A study of nodular disease shows that its importance is largely due to the following factors:

The adult parasite is capable of injuring the mucous membrane

of the intestine causing irritation, congestion and inflammation. The young worm and the lesions resulting from its cystic stage are a source of great irritation.

The development of the nodules in all stages, if present in any numbers, interferes with the proper absorption of food very materially affecting the development and health of the host.

There is clinical evidence to suggest that, in addition to the interference with the absorption of food, a toxic substance is thrown into the system resulting in a mild chronic toxemia. The toxic substance may come from the nodule itself, or, through the weakened tissue, from the intestinal tract.

The injury to the mucosa by the adult parasite, the lesions resulting from the presence of young encysted forms and the old nodules all open the way to secondary infection both specific and nonspecific.

The above factors result in the following clinical evidence varying somewhat in the different species: enteritis, diarrhea, unthriftiness, emaciation, peritonitis, hepatitis and septicemia.

Nodular diseases of sheep, caused by Oesophagostomum columbianum commonly spoken of as the "nodular worm," is reported as being more or less prevalent in all parts of the United States. It is, in my opinion, an important economic factor to the sheep industry of the State of Iowa. Probably at no time in the history of the State has the prospects for the development and extension of the sheep industry been as promising as at the present time. Nodular disease in sheep as it exists today deserves our best efforts in an attempt to prevent further spread of the disease and to eradicate it from those sections where it is at present commonly met with.

Oesophagostomum columbianum is very commonly met with in the intestines of Iowa's sheep. Its presence causes intestinal disturbances, as well as nervous troubles believed to be caused by the absorption of poisons, either secreted by the parasite, or, thru the weakened intestinal wall, from the intestinal content. The structure of the head and mouth parts make it more easy for the parasite to attack the mucous membrane causing the intense congestion and hemorrhage usually found accompanying its invasion.

2. Description: *Oesophagostomum columbianum.* Sheep. Body attenuated posteriorly. Mouth circular, sustained by a horny ring armed with two crowns of teeth of which the internal are the smaller, and surrounded by a cutaneous ring on which are six pointed papillae. This ring is succeeded by a slight elongated constriction, terminated by another ring at the ventral transverse slit. Toward the interior fourth of the oesophagus are two opposed papillae, and at the anterior quarter of the body are two narrow wings on each side.

Male: Length 12-15 mm. Caudal pouch slightly sinuous and shallow with same rib arrangement as in O. dentatum.

Female: Length 14-18 mm. Vulva a little in front of the anus. Eggs ovoid, 90-50 microns. See Fig. No. 7.

3. Symptoms: The early symptoms of nodular disease in sheep are usually not sufficiently marked to be noticed. There is evidence indicating a considerable systemic reaction at the time of the first invasion of the intestinal wall by the parasite. Our observations, however, have not been carried far enough to confirm this point. A general indication of nodular disease is the failure to gain, altho the appetite may be good. Chronic diarrhea, unthriftiness and a loss of flesh to the point of emaciation are indications that would naturally call one's attention to this disease. The fact that animals, which have never shown any indication of disease, upon being killed for food, show large numbers of these nodules, would suggest that in those cases where more or less severe symptoms result, complications such as bacterial infection, or intoxication are probably important factors, and may be largely responsible for the symptoms that the affected animal may show.

4. Lesions: The nodules of recent invasions are small and show little or no inflammation in the surrounding tissue. They are located in the submucosa and wall of the intestine, and the eggs (?) embryos and larva may be found within those more recently formed. Apparently the young worm escapes at an early date, after which the nodule continues to develop. The changes taking place in the nodule following the escape of the parasite are necrosis, inflammation and the development of a more or less distinct fibrous capsule. These changes are to be looked upon as a reaction of the tissue to the presence of the foreign necrotic material, and an attempt upon the part of the tissue to surround this foreign material and any micro-organisms that may be present, thus preventing systemic absorption. The necrotic material in the nodule commonly becomes greenish in color and later extensive calcification is often found. The greenish color is looked upon as being more or less characteristic of the nodules of this disease in sheep. These nodules are often irregular in outline, forming one large irregular mass. The completely developed nodules are subserous, projecting beyond the normal level of the serous surface of the intestine. In most cases the mucosa over the nodular area is intact, altho it is, as a rule, not normal and in some cases, there seems to be a direct communication from the nodule to the lumen of the gut. Frequently nodules are found outside the intestinal tract, especially in the mesenteric lymph glands, and in the fatty tissue along the intestinal tract, particularly the posterior bowel and the liver.

5. Life History and Prevention: Since methods of prevention are based upon an accurate knowledge of life history cycles, nothing definite can be given under this head. Practically nothing is known of this parasite after it leaves the host. It is quite probable to assume, however, that infestation occurs by the ingestion of foods and water which are contaminated with either the ripe ova or some nymphal form of this nematode. The life history given for the Oesophagostomum columbianum is based largely on a few disconnected facts, such as the adult parasite in the intestine; the young larva in the recently formed nodules; and the passage of eggs and larval forms with the feces. Using these few findings for a foundation previous investigators have apparently filled in with biological laws and theories and have presented the life history as it is now known.

1. Dr. M. H. Reynolds states, "The life history of this parasite is now quite well understood, although the disease has been recognized but a comparatively short time. The eggs are laid by the adult female in the intestine. The eggs soon hatch, and the embryo worms pass, in some way, through the internal lining of the intestine, and become embedded there, giving rise as foreign bodies to the little tumors or nodules which nature throws around them evidently in an attempt to fence them off."

2. "Its history is known from the passage of the eggs with the feces to the entry of the embryo with food or water and its encysting itself in the walls of the intestine. From the cyst however it escapes into the intestine, reproduces its kind and dies.

1. "An Experience with Nodule Diseases of Sheep," by Dr. M. H. Reynolds, Expt. Station, St. Anthony Park, Minn.

1900 Am. Vet. Review. Vol 26, p. 416.
2. Laws. Vol. 5, p. 339.

A recent study of the submucosa of the intestine of lambs affected with nodular disease, revealed a variety of nodules differing from those containing the larval form of the parasite. Embedded in the mucosa of the intestinal wall were nodules much resembling the place of attachment of a tape worm, possibly a little smaller. Upon examination these nodules were found to be made up of a great many very small eggs, which appeared to have been laid in clusters presenting much the appearance of a berry in cross section.

The individual eggs were small, oval in shape, measuring 21.1 by 15.9 microns and presenting a very smooth outline.

The only parasites which were found in the intestine were the Strongylus filicollis, Taenia neumanni and Taenia expansa, and in the stomach was found the Haemonchus contortus. On com-

paring the eggs of these parasites with those found in the nodules, both in structure and measurements, it was readily seen that they could not be the eggs of any parasite present.

As stated above no species of Oesophagostomum was found in the intestine. This may be explained by the fact that these lambs had been treated two weeks before and the parasite expelled. Further this may be explained by the fact that mature worms are seldom found, it being assumed that they pass out, or leave the intestine, soon after oviposition.

It would seem quite plausible to advance a new theory regarding their life history. The finding of the eggs in the intestinal wall of the lamb leads us to believe that the *mucosa is penetrated by the adult female and oviposition takes place in this opening in the intestinal mucosa.* These eggs then hatch and the larval embryos normally enter the intestinal lumen where they pass out with the feces and, after a period of external existence are ready to be taken in with the food or water, by the host.

In further proof of this idea the following will not be without value. In examining the intestine of a sheep invaded with these nodular worms, a close study was made of their *attachment* resulting in the following observations. Ofttimes they are found free in the intestinal content, apparently doing no damage and, for the time, being merely commensals; other times they are attached to the mucous membrane by the *mouth* parts, sucking blood from the tissue which they lacerate with the fine leaf-like lancet teeth.

Again the females are found fastened quite firmly to the mucous membrane by the *caudal* end, the head and body floating in the lumen of the gut. It is *this* position of fixture that I want to present in upholding my statement of a new life cycle theory. If these females are carefully pulled free from their point of attachment, a small bladder-like tissue structure will be seen protruding from this part of the body. Upon microscopical examination, this bladder proves to be the everted oviduct of the pregnant female, containing the eggs described above which are apparently being forced under the soft layer of mucous membrane, and there to pass their first incubation period. See Fig. 7a.

The nodular worm illustrated showed the following measurements (Fig. 7b):

Total length	18.	mm.
Width	.36	mm.
Depth of mouth ring	.09	mm.
Width of mouth ring	.18	mm.
Length of oesophagus	1.2	mm.
Width of oesophagus	.131	mm.
Width of oesophagus bulb	.2	mm.

Length of oviduct	3.5	mm.
Width of uterus	.1	mm.
Length of egg	21.1	microns
Width of egg	15.9	microns

The larvae which fail to come out of the intestinal wall are those which have been studied in the nodule and described as penetrating the mucosa in the early larval form. A study of nodular disease would seem to suggest that these encysted larva never succeed in reaching the lumen of the intestine but die and remain as foreign material. The dead, destroyed tissue elements and the intervention of bacteria all act as causes for the further enlargement and extension of the necrotic process going on in the nodule. The fibrous capsule is a result ofthe inflammatory reaction around the nodule. Calcification is common to all non-vasular necrotic areas, especially those of parasitic origin.

Introduction: Nodular disease of pigs, from our experience, would seem to be far more frequent and important than is generally known. My attention was first called to the lesions resulting from the action of the Oesophagostomum dentatum from examination of specimens sent to me from Hawkeye, Iowa, by Dr. N. O. Bevins. (1912). This parasite is met with in at least 50 per cent of the pigs presented for post mortem and, in many of the cases nodules are found that apparently caused more or less disturbance. The parasite in the intestine causes congestion and inflammation of the mucosa. The early nodules are mere points on the serosa of the large intestine, red in color, within which can be found the young worm. The older nodules are in the form of round subserous abscesses, in which the parasite is never found.

1. Definition: Oesophagostomiasis of pigs is a form of parasitism characterized by the presence of the Oesophagostomum dentatum in the colon of the pig. The presence of the parasite causes congestion and inflammation of the mucosa, the injury of which opens the way for invasion of microorganisms that not infrequently, result in abscess formations in the wall of the intestine, and peritonitis. In the development of the nodules two rather characteristic forms are seen: the early nodules, just beneath the serosa, small and red in color and in which may be found the larval form of the parasite and the final form, which is a round subserous abscess with a dry necrotic center, in which micrococci are found, surrounded by a distinct well formed fibrous capsule.

2. Description: *Oesophagostomum dentatum.* This is a small worm of pigs found in the colon and sometimes in the caecum and small intestine. Body straight, slightly narrowed at both extremities mouth circular surrounded by two ridges,

the inner one horny and furnished with bristles, the outer transparent and furnished with six pointed papillae. Cuticle striated; indented just back of mouth on one side to form a wing. The oesophagus is pear-shaped and there are two papillae that point inward in the posterior quarter. The intestine is wide.

Male: Length 9-12 mm. Caudal pouch bell shaped with a faint middle lobe. There are two delicate spicules.

Female: Length 8-15 mm. Tail fine and sharply pointed the ovaries extend the length of the parasite the vulva being just in front of the posterior extremity. See Fig. 8.

3. Symptoms: The symptoms of Oeosophagostomiasis in swine are so far as observations have been carried, in no way marked or characteristic. All the animals in which we have found this parasite have been those that died or that were sick and were presented for post mortem. In a few cases we have had reports from practitioners stating that a number of pigs in a herd had died and that post mortem failed to show gross lesions other than inflammation in the large intestine, nodules and sometimes peritonitis. A laboratory study of the tissues failed to reveal any cause or lesions other than those caused by the parasites. These findings would seem to warrant the conclusion that general evidence of unthriftiness, intestinal irritation, weakness, anemia with constipation followed by diarrhea, with normal or only very slight elevation of temperature and possibly a few deaths may be put down as general clinical evidence of this disease. The fact that we find this worm in apparently healthy animals and without lesions that come from the activity of the parasite, forces us to believe that the parasite may be present in the intestine without causing evident disturbance. It is very probable that only during certain stages of development is the parasite active. For example during the reproduction period and especially during the deposition of eggs and the formation of nodules.

4. Lesions: The tissue changes resulting from the presence and activity of this parasite are congestion and inflammation of that portion of the intestine in which the parasite is present (colon), and the formation of submucous and subserous nodules. The nodules in their more characteristic form are subserous. The early nodules are very small from a pin point to a pin head in size, bright red in color and showing mild inflammation of the surrounding structure. By first treating the formations with caustic potash the parasite can readily be seen within these young nodules under a low power microscope. The older nodules are about the size of a small pea, white or gray in color, very round and completely encapsulated, the content of which is a purulent necrotic nature. In the old nodules we have

never been able to find the parasite, and have never yet seen a nodule that was calcified. Many times we meet with forms of peritonitis that have apparently resulted from infection that gained entrance through the nodules. In other cases we find that the animals lose condition and become more or less emaciated, suggesting that the disease tends to a general interference with the health and growth of the host. Enteritis found accompanying nodular disease suggests the possibility of the injury to the mucosa opening the way for infection that may finally terminate in a chronic infectious enteritis. See Fig. No. 9.

The diagnosis of the disease is not difficult, the nature of the lesions and the finding of the mature worm in the intestine being characteristic. However, when this condition is met with in animals suffering with other diseases, septicemia, peritonitis, enteritis, chronic emaciation, etc., it is almost impossible, considering our present knowledge of the condition, to tell which was primary. It would seem reasonable to conclude that the injury and actual puncture of the mucosa of the intestine by the parasite often opens the way for forms of infection that prove to be very troublesome and serious. In our work we have met with a number of herds where 5 to 10% of the pigs had died, and many others were not doing well, in which the only evidence of disease that could be demonstrated, either from the gross pathology or laboratory test, was that of nodular disease. Small grayish white nodules frequently seen in the submucosa have been found to contain parasite eggs. These nodules resemble those found in the sheep, and since finding a pregnant female actively forcing her eggs under the mucosa (see sheep) we may assume that these likewise are the eggs of the Oesophagostomum dentatum.

5. Life History and Prevention: Little work has been done on the life history of this parasite. However, if the general methods of infestation are typical of this disease, the importance of cleanliness in the hog lots may readily be seen. The conditions under which pigs are generally kept probably causes this disease to be more prevalent in these animals than in those for which rotation of runs is practiced and where waste materials from the pens is properly disposed of.

In an attempt to throw some light on the life cycle of the oesophagostomum dentatum the following experiment was carried out: On June 1, 1916, some mature female worms were obtained from a pig and a number were placed in a glass dish of moist earth. This was allowed to dry and was kept for about five weeks at room temperature. For 3 to 4 days the contents of the dish was kept saturated with water and on July 9, 1916, the moist earth was placed in the drinking water furnished two

pigs. The pigs weighed about 100 pounds each, were cholera immune, were kept on a cement floor that had been cleaned and disinfected and each animal had been previously treated twice for intestinal parasites. The vermifuge used was santonin, calomel, areca nut and sodium bicarbonate. No evidence of parasites was observed in the feces of the treated pigs. For two months the pigs were kept on a cement floor free from all dirt and waste and received during this time only grain for feed and well water to drink. Upon slaughter September 9, 1916, the walls of the large intestines in both pigs were found to be literally studded with small white or grayish, rather hard nodules. In the gross no nodules showing redness, such as we consider typical of early infestation could be seen, nor were there any that we consider typical of the mature nodule (a round necrotic encapsulated mass), but all nodules found were fibrous in character and showed only a small necrotic center. Microscopic examination failed to reveal any evidence of the parasite.

There seems little doubt but what the nodules found in the pigs were the result of the action of the oesophagostomum dentatum yet the nodules were not what we consider typical and since only two pigs were used in the experiment no very definite conclusion can be drawn. No eggs of adult worms of any species were found in the intestines of the pigs.

NODULAR DISEASE OF CATTLE.

Introduction: Nodular disease in cattle is comparatively rare. The adult parasite, met with in the lumen of the intestine, is capable of injuring the mucosa and causing more or less irritation. It is generally understood that the eggs or embryos pass out from the intestinal tract and that later they are taken in as larval forms which penetrate the wall of the intestine, producing nodules. However, there is some evidence to show the possibility of the mature female's deposition of the eggs directly into the wall of the intestine. The nodule resulting from the presence of the parasites consists, in the early stages of a dark or black circular area, the black area being of irregular granular material, possibly broken-down haemoglobin, and a clear or light central area in which can be found the young parasite. The lesion develops beneath the mucosa and, by cutting off the involved area and treating with caustic potash, the parasite may be readily seen. The generally accepted theory of the life history is that, after a certain length of encystment, the larva continues to grow and, apparently undergoing certain changes, but never becoming mature, passes out into the lumen of the intestine where it acquires complete sexual development and reproduces, the eggs passing out with the feces. In those cases

where the parasites fail to escape into the lumen of the intestine they ultimately die. The continuation of the growth of the nodule after the disappearance of the parasite is probably due to the fact that the nodule has become invaded with microorganisms. The tissue detritus remaining from the parasite is not removed and is augmented by microbian activity. As a means of protection to the surrounding tissue the lesions become more completely encapsulated and in many cases become calcarious in character. The finding of nodules in the wall of the intestine of cattle would of course suggest nodular disease, and the finding of the nodules with adult parasites in the lumen of the intestine would be considered positive. The finding of nodules without the adult parasite would require a careful study before a diagnosis could be made. However, the finding of the parasite together with the nodule, especially in the early stages, would seem to me to be sufficiently characteristic to enable one to make a diagnosis of nodular disease.

1. Definition: Nodular disease of cattle is caused by the Oesophagostomum radiatum, and from the number of cases which we have met with it would seem quite prevalent in this country. The usual habitat of these nematodes is in the small intestine, giving rise to the characteristic nodules, which seem to play so important a part in the life history of this parasite. Quite frequently it will migrate to the large gut where the characteristic nodules will be found, slightly displacing both the mucous and muscular layers of the intestine. It is justifiable to ascribe some of the more obstinate diarrheas and emaciations met with in cattle to the invasion of this parasite. In some cases where infestation becomes severe the disease may take on an enzootic form, and the statement is made by some authors that in such outbreaks, the mortality may reach as high as fifty per cent. Our experience would indicate that fatal results from this parasite are not common, but nevertheless the disease is a serious one in this state. Further in those herds where a number of animals have died showing the presence of the worm, or the nodules, investigation has shown that the immediate cause of death was due to infection, specific or non-specific, the organisms gaining entrance by means of the predisposing action of the parasite.

2. Description: *Oesophagostomum radiatum. Cattle.* Mouth circular with a prominent rim having six papillae. Anterior extremity provided with an ample transparent cutaneous enlargement immediately followed by two lateral membranous wings which are traversed by a single papilla.

Male: Length 14-15 mm. Caudal pouch faintly trilobate.

Female: Length 16-20 mm. Vulva situated a little in front of anus and surrounded by a ring. See Fig. No. 10.

Symptoms: Nodular disease in cattle, caused by Oesophagostomum radiatum, is far less frequently met with than in the case of sheep and pigs. The disease is characterized clinically by obstinate diarrhea and emaciation, and in the more chronic forms the animals fail to gain in flesh although on full feed. The adult parasite is found in the lumen of the small and large intestine.

The symptoms shown by cattle suffering from nodular disease depend largely upon the extent of the infestation and vary according to the age of the nodules and general condition and resistance of the host. One of the principle symptoms that may be shown is a more or less chronic enteritis combined by a watery diarrhea, the animal rapidly or gradually losing condition and becoming more or less anemic and, in severe cases, emaciated. Reports have been received at various times, regarding severe forms of diarrhea in cattle. Many of these cases have been diagnosed clinically as Johnes disease but the diagnosis has seldom been confirmed. Thus the importance of a differential diagnosis. Diarrhea from various other causes, especially Johnes disease and bovine coccidiosis (both of which have been identified as existing in this state,) must be carefully studied before a diagnosis is attempted. The cases of nodular disease in cattle, that we have had an opportunity to study, were animals that died from other diseases, particularly hemorrhagic septicemia. As stated before it is quite possible that nodular disease opens the way for this infection.

4. Lesions: The early lesions in the wall of the intestine are not in the form of nodules but appeared as a black circular area in the submucosa with a clear center in which is found the young worm. Congestion and inflammation of the mucosa in the affected portion is always evident. The structure of the mouth parts of this parasite enable it to attack the mucosa, thus producing rather extensive injury, inflammation and hemorrhage. The parasite is usually fastened securely to the inner lining of the intestinal wall making them quite hard to remove. It would seem that during certain periods of its growth it fastens itself securely to the mucosa while at other times it is free in the lumen. The appearance of the early nodule, according to our observation is, on gross appearance, a black, granular area in the submucosa. Closer study reveals a black, granular pigmented ring inclosing a lighter area in which may be found the encysted larva (see Fig. 11). A slight inflammatory reaction will be seen just outside the ring of pigment. The older nodules are made up of a fibrous capsule inclosing a nec-

rotic mass. From personal observations and from reports of others on nodular disease of cattle it would seem that the old nodules do not project as subserous abscesses to the degree that is true in sheep and pigs, but that they are located more in the wall of the intestine. Calcification takes place but not to the extent met with in sheep.

5. Life History and Prevention: As for the sheep and pig, again nothing definite can be given under this heading, the entire cycle of which is not known. However, as ir the case of all forms of parasitisms of round worms in which certain parts of the life cycle are passed outside the body of the host and in which the parasite gains entrance into the body by means of contaminated food and water, it may be assumed that efficient methods of prevention can best be carried out by the proper disposal and treatment of all contaminated material and areas. Since the presence of the worm is in the early stage of infestation almost never known, and can not then be expelled by the use of a vermifuge, and treatment of the animal after the formation of the nodules is useless, therefore, prevention and control measures become the only method of handling this disease.

We are all agreed that the various forms of parasitisms met with in our domestic animals are important and in many cases serious. First from the fact that many cases terminate fatally and second because the failure of the animal to grow during the time that they harbor the parasite, and in many cases the failure to properly mature even after expulsion of the parasite, resulting in serious economic losses. Personal experience entitles me to say that the treatment, prevention, and eradication of animal parasites offers a great opportunity to the veterinarian to demonstrate to his clients how a technical knowledge of medicine and an understanding of biological laws can be put to use in the most simple and practical way.

Some of the most common forms of parasites have been known and were accurately described over 200 years ago. Suppose we make this knowledge; the name of the parasite, its action, migrations and life history so far as known, a part of our every day vocabulary and take parasitisms forever away from that class of conditions that can be dealt with successfully through the promiscuous use of conditioners, stock tonic, and patent worm mixtures by those wholly unfamiliar with biological laws and the science of medicine. To successfully handle herds that are suffering with any of the various forms of parasitisms due to worms, we must take into consideration in great detail the following.

1. Expel all worms from the host.
2. Destroy all ova and larva.

3. Prevent infestation and reinfestation by control of food and water, disinfection of pens and rotation of pastures.

Following complete expulsion of the parasites from the host the importance of destroying all eggs and embryos is axiomatic, if we are to prevent reinfestation and finally eradicate from the premises those forms of parasitisms due to worms.

THERAPEUTIC MEASURES IN THE ERADICATION OF CERTAIN ANIMAL PARASITES.

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Gentlemen: Parasitic infestations of the domesticated animals with the resultant tendencies toward pathological changes in the infested organs, or general debility very often resulting in death of the individual, are becoming extremely frequent in this country, and the tendency toward parasitic diseases will undoubtedly be still further increased, owing to the greater number of animals being produced on the farms of smaller acreages, closer housing, and all those conditions which tend to bring the animals in closer contact to one another. The varieties of parasites infesting animals are so numerous, and the subject is of such great economic importance, that animal parasitology has become a special and extremely important branch of science.

Young stock is usually most seriously troubled by parasitic invasions. This is partially due to the fact that the invading parasites deprive the host of considerable nourishment, and in young animals struggling for growth as well as maintenance, this results in the general symptoms of unthriftiness, debility, and anemia so often noticed. While some species even though present in considerable numbers seem to produce no outward symptoms, the host being apparently healthy, other species bring about diseased conditions, outbreaks of which often cause greater losses than some of the severe contagious or infectious diseases, and indeed are frequently more difficult to control.

The ways in which parasites may produce disease in the animal body are numerous. Their detrimental influences are not solely dependent upon numbers, nor upon the fact that they deprive the host of considerable nutrients intended for the building of its own vital substances.

It is a well-known fact that parasites produce in their bodies toxins which are being constantly eliminated and absorbed by the host. Extracts made from the common Ascaris will kill a dog if injected intraveneously in small amounts, and sterile body liquids from these same parasites if applied locally to certain mucous membranes will cause marked inflammation. The mechanical irritation produced by the presence of the parasites also causes inflammations, thereby producing an excellent seat for bacterial infection. Certain of the parasites

are blood suckers, thus sapping the vitality of the host, as well as injuring the mucous membranes, inoculating with bacteria, producing inflammations, and often ulcerations and hemorrhage. The mature parasites or the larvae often migrate into other organs, for example, the liver through the bile duct from the intestines, or penetrate the mucous membranes and enter the circulation causing embolism. Aside from the mechanical occlusion brought about in these cases, the fact that the parasites carry bacteria with them is also of importance. Complete obstruction of the intestines causing impactions are not unusual, and diarrhoea due to intestinal irritation is a common symptom. The interference with digestion and absorption in the alimentary tract is also one of the important causes of the malnutrition accompanying parasitic infestations of the intestines. The parasites themselves are not affected by the powerful digestive enzymes, as they contain an anti-enzyme substance, probably similar to that contained in the stomach and intestinal walls which prevents their disintegration by enzyme action.

In the combating of disease conditions due to parasites, at least three objects must be aimed at by the practitioner. (1), as in the treatment of any diseased condition the primary object being to remove the cause if possible, in this case, the invading parasite. (2), the detrimental effects produced by the parasites must be combated. If this is general debility, forced nutrition and tonics are indicated, and this often is the very essential part of the after treatment. If local irritation of the bowel is present accompanied by diarrhoea, this should be taken care of. (3), prevention of further infestation must be attempted, and in order that the practitioner may advise intelligently in this regard, certain knowledge regarding the life history of the particular parasite is essential. Parasites do not multiply indefinitely within the body of the host. As a rule the mature parasite deposits the ova within the body, which pass out with the excreta and develop to the larval form outside the body. The larvae are then reingested most commonly through contaminated feed or water either about the stables or in the pastures. Low, marshy pastures are particularly dangerous, as the larvae develop best in the presence of moisture, and there is good opportunity in pastures of this kind for the animals to secure water contaminated with feces. In this country it is hardly practicable to treat pastures with therapeutic agents such as ferrous sulfate, salt, etc., to destroy the larvae and ova as is sometimes done in the European countries. Change of pastures for a year or so may be practiced and when animals are known to be on infested pastures periodic doses of anthelmintics are indicated whether the animals

show evidence of infestation or not. Watering places, barns, yards, etc., should be kept clean, dry as possible and frequently disinfected, as accumulations of manure, soiled bedding, etc., are very common sources of infestation.

It is the intention in this paper to discuss some of the more logical therapeutic measures which may be adopted in eradicating certain of the more serious parasites commonly infesting the domesticated animals in this state, and also to a limited extent mention preventative measures.

There are a number of therapeutic agents of great value to medical science, not because of any marked physiological action they may have upon certain of the body organs, but because of their effect on certain parasites whose presence in the body is the causative factor of disease.

Drugs used for their destructive action on the causes of disease may be divided into three groups: (1), those used to eradicate invading parasites; (2), those used to combat protozoal infections; (3), those used to destroy or prevent growth of bacteria.

Medicinal agents used to combat parasitic invasions of the animal body are commonly spoken of as either anthelmintics or parasiticides. Parasiticides usually refer to drugs which are used more especially against those parasites inhabiting the skin. Anthelmintics refer to those agents used for the eradication of parasites from the alimentary canal. They usually include vermicides which destroy the parasites, and vermifuges which cause their expulsion from the alimentary tract, the latter being usually of a purgative nature. Most of the drugs used as anthelmintics seem to depend for their action upon principles which are muscle poisons. They do not as a rule completely kill the parasite, but simply paralyze it so that it may be carried along and expelled with the rest of the intestinal contents by the normal bowel movement, or by purgative medicine introduced. For this reason anthelmintics should always be used with, or followed by, an active cathartic to remove either the paralyzed parasites or the dead ones, together with as far as possible the ova, larvae, or whatever other undeveloped form may be present. It is obvious that the value of an anthelmintic depends not alone upon its power of paralyzing the invading parasite, but also upon its harmlessness as regards the patient. Many of the drugs used to destroy the parasites are also toxic to the host, and since the anthelmintic is to attack the parasite and not the patient, and the parasites are just as apt to be found in the adult stage in the young host as in the adult host, the general rules of dosage do not apply.

It becomes necessary then to avoid toxicity with the drug, but yet to administer a sufficient amount to exert action upon

the parasites. Parasites of course can only be actually expelled from the body when they are situated in the lumen of a cavity with a fairly direct opening to the exterior, such as in the intestines or stomach. If the parasites burrow into the walls of these organs, or localize in certain other of the body tissues, the action of the drug is not of much value. It is possible, however, for parasites or their larvae to be destroyed in the circulation, or in organs such as the lungs, nature then looking after their disposal through absorptive processes, encapsulation, etc.

There are certain rules which govern the administration of anthelmintics which should be remembered. Before the administration of an anthelmintic it is advisable to starve the patient from twelve to twenty-four hours and to give a brisk cathartic, the object being to have the alimentary canal as empty as possible, so that the drug may act with the greatest possible force upon the invader. The dose is then administered and this followed in a few hours by a purge to carry out the dead or paralyzed parasites. Various kinds of parasites require different kinds of treatment, as drugs that will eradicate one species frequently do not materially affect another. The various drugs acting upon the parasites are used singly or in combination, depending upon their efficacy, cost, convenience of administration, tolerance of the patient, etc.

Those who are not accustomed to treating sheep should bear in mind that drenching a sheep, as with a hog, is a delicate matter, but not at all dangerous if properly performed. The sheep should be stood squarely on all four feet. An attendant standing astride the sheep should hold it by its cheeks and raise its nose to just about on a level. As should always be the rule when giving liquid medicine to animals, care must be taken not to pour it too quickly into the mouth, and to leave the jaws and particularly the tongue as free as possible under the circumstances. Care should be taken not to hold the patient's nostrils closed and to avoid any unnecessary struggling. While the most common method of drenching is with a long, slim-necked bottle, the drenching tube, which may be very easily made, is much more satisfactory for sheep and calves. A piece of rubber tubing three-eighths or one-half inch in diameter with a small funnel inserted in one end and a piece of metal tubing four or five inches long in the other makes an ideal drenching tube. The metal tube is placed between the molar teeth and the sheep allowed to bite upon it. The drench is then poured into the funnel by an assistant while the one who holds the metal tube between the animal's teeth can control the head with one hand, and by holding the tube near the point of union of the tube and rubber, can readily regulate

the flow of fluid by pinching the rubber. The same method is applicable for hogs, the animal usually being placed on its haunches and nose not brought above a level. When sheep are dosed in the standing position or upon the haunches, care must be taken that the nose is never allowed to go above a level with the eyes, or there is great danger of the dose going into the trachea. The author is of the opinion that unless unavoidable, a sheep should not be laid on its side or back or set upon its haunches for drenching. The standing position is easiest and least dangerous.

ASCARIASIS.

Ascarides (round worms), and the detrimental results of their presence are very often observed in young animals. Adult animals are more rarely affected and then usually by only a few of the worms. Any of the various species of domesticated animals are liable to infestation with round worms, of which there are six or seven varieties.

Infestation occurs through licking objects, eating food, or drinking water which have become contaminated with ova or embryos passed with the feces of infested animals. Contaminated barn floors, pastures, the locality of watering places, and soiled bedding or feces which the animals may lick are common sources of infestation. While the normal habitus of the worms is the intestine, yet not infrequently they migrate into the stomach, causing vomiting in the dog, cat, and pig.

In this state infestations with round worms, causing evidence of disease in the infested animals are very frequently met with in pigs, calves, lambs and foals.

Ascaris Suilla usually infests the small intestine of pigs. The adult worms vary from six to ten inches in length, the female being longer than the male, are smooth, cylindrical, and pinkish white in color.

These worms may be successfully eradicated from pigs by means of a number of different lines of medication which may be administered in the feed. The following combination gives better results than any other medication yet tried by the Veterinary Division.

RX Santonini, gr. vi or viii.
Arecae pulv., ℥. ii.
Calomel, gr. ii or iii.
Sodii bicarbonatis, ℥. i.
M.

The above is a single dose for a 100-pound pig and should be varied according to the size of the animals under treatment. It is best to prescribe as powders and have each powder contain a sufficient dosage for ten pigs, inasmuch as dosing

ten only at a time will enable the owner to see that each gets its share. The animals should be starved for eighteen to twenty-four hours and the treatment mixed with a small amount of wet feed or in slop.

Betanaphtol in 20-grain doses is said to be quite efficacious when substituted for the santonin in the above combination, the prescription being administered in watery swill. Oil of turpentine is one of the common anthelmintics given to pigs for round worm infestations in from 1- to 3-dram doses, depending upon the size. It should always be diluted at least ten times in thin slop, oil, or milk, and followed by a cathartic. The smaller doses are sometimes given daily for several days.

The following combination, given in the same manner as the santonin formula, often gives good results:

RX Ferri sulfatis, gr. xxx.
Cupri sulfatis, gr. xxx.
Arecae pulv., ʒ. ii.
Calomel, gr. ii or iii.
Magnesii or Sodii sulfatis, ʒ. ss.
M.

The above is a single dose for a 100 pound pig and should be repeated three times about one week apart. Tartar emetic which works so satisfactorily in certain of the other domesticated animals, has recently been used in pigs with apparent success. Further experimental work as to dosage and method of administration is yet necessary in order to prove its efficacy and practicability of use. The Bureau of Animal Industry recommends 45 drops of oil of chenopodium in 1 ounce of castor oil for a 100 pound pig and each pig to be treated separately.

The whip worm of swine (Trichocephalus Crenatus) may be eradicated by the same lines of treatment as recommended for the round worm. The thorn headed worm (Echinorhynchus Gigas) seems to be most readily eradicated by the oil of turpentine treatment.

Attempts to prevent reinfestation should be made by following the vermifuge treatment with a thorough cleansing of the lots and houses of all manure, free sprinkling of lime, or strong disinfectants, and disinfecting the troughs, feeding floors, etc., with boiling water.

Ascaris Vituli (Ascaris Bovis) infests the small intestine of calves, exceptionally also found in the abomasum, rarely in adult cattle. The parasites vary from six to ten inches long,

the female being the longer, and are reddish white in color. The following combination gives good results in calves:

RX Antimonii et Potassii Tartratis ʒ. i.
Aquae, ℥. iv.
M.

Give a tablespoonful in milk every four hours. A physic of salts may be administered if the animal is not extremely weak, and followed with a combination of tartar emetic 10 grains and ferrous sulfate twenty grains three times daily for three or four days followed by a physic. A combination of turpentine 2 to 4 drams in one half pint of milk given once daily, in the morning for two or three days, also gives results in these cases. 5 to 10 ounces of a 1 per cent solution of coal tar creosote, or 1 to 3 drams of Pearson's creolin well diluted in milk are highly recommended for calves from three to eight months old. The latter treatment is preferable for a number of reasons. The above treatments refer particularly to calves; treatment for ascariasis in young cattle will be given in discussing oesophagostoma infestations later on.

Ascaris Ovis: Inhabits the small intestine of sheep, but is not extremely common. The parasites vary from four to six inches in length and are yellowish white in color. The treatment is similar to that for calves with the dosage cut proportionately. Precaution must always be taken in administering medicine as a drench to sheep. Inasmuch as ascarides infestations may be treated successfully with any of the anthelmintics recommended for the oesophagostoma, detailed discussion of treatment of both these infestations in mature cattle and sheep will be taken up under oesophogostomiasis.

Ascaris Megalocephala: Infests particularly the small intestine of horses and mules. The parasites are eight to twelve inches in length, and yellowish white in color. Treatment beginning with the proper sized aloes bolus depending upon the size of the animal, followed by a capsule of 1 to 2 drams each of tartar emetic and ferrous sulfate given preferably before feeding for three or four mornings in succession, and followed with an aloes bolus will ensure eradication. These same doses of tartar emetic and ferrous sulfate, may be given in the feed twice a day for four or five days and followed with aloes. This treatment may be repeated as needed at intervals of a week or ten days. Arsenic 5 grains may be combined once a day with this treatment. 1 to 4 ounces of oil of turpentine in a pint or so of linseed oil will often give good results, or rather than in a single dose the turpentine may be given for two or three mornings in succession in a pint or so of milk, and followed by the

oil or other purgative. Various other lines of treatment may also be used as follows: Carbon disulphide 2 to 4 drams for adults and 1 to 2 drams for young horses, given in capsules three or four times in a day and followed in eighteen hours by a purgative; carbolic acid 1 dram, or lysol 2 drams in a pint of milk daily for a few days followed by a purgative; thymol 10 grains to 1 dram in a bolus or capsule for three days and followed by a laxative other than oil.

Any of the above lines of treatment must be repeated as signs of the parasites reappear. Prophylaxis consisting of thorough cleaning of the quarters occupied by the infested animals, burning of all litter, etc., drying out of the quarters if damp, isolation of infested animals if practicable, scattering of lime, or soaking the ground with a five per cent solution of chlorinated lime, or strong solutions of coal tar disinfectants, are recommended.

OEOSOPHAGOSTOMIASIS.

Disease caused by the larvae and mature worms of the genus Oesophagostomum occur quite generally in the United States and is very prevalent in this state. Cattle, sheep, and pigs are most commonly affected. The mature worm is from one-half to one inch long. One of the chief anatomical changes noticed in an infestation with this parasite is myriads of nodules varying in size from a pinhead to that of a pea, or frequently as large as a hazlenut, in the intestinal walls. These nodules are composed of a connective tissue capsule and may contain a small amount of caseous or purulent matter, or in some cases this material is calcareous in nature. These nodules are due to embryos which probably develop outside the body from the ova passed with feces of infested animals, and are then taken back in through contaminated food, water, etc. The embryos embed themselves in the mucous membrane of the intestines forming cysts which are more noticeable upon the serous surface, where they proceed with their development. In intense invasions these cysts become so numerous as to interfere with digestion and absorption in the intestines, and also serve as a source of irritation. The adult worms are blood suckers, piercing the mucous membrane and sucking the blood, thereby causing general debility, anemia, intestinal irritation, diarrhoea, and often death.

Oesophagostomum Radiatum: Infests cattle, particularly the small intestine and caecum, and may cause great losses as may be seen from the followng excerpt:

In Vol. VI No. 1—1911 American Journal of Veterinary Medicine, Dr. F. Lucky, State Veterinarian of Missouri reports a number of cases of infestations in cattle with oesophagostoma inflatum (radiatum) as follows:

A. Out of one lot of 102 head of short yearlings shipped to southeast Missouri in February, in September 23 were dead and the rest in very poor condition.
B. In an outbreak in Jasper County, Missouri 23 head died out of a herd of 36 head.
C. In Grundy county 83 head died out of a herd of 320 head.

The above and many other cases of losses have been reported due to this parasite. Two infestations have come to our attention in Iowa recently.

The adult worm is thread like, white in color, and from three fourths to one inch long. The treatment consists in prophylactic measures such as a change of pastures particularly if wet and marshy, forced nutrition, and attempts to destroy the adult worm in the intestinal tract. Variable results are always attained in the treatment of ruminants with anthelmintics, on account of the great dilution of the drug attained, particularly if given in a fluid form, before reaching the usual seats of infestation, either the abomasum or intestines. If the medicines pass first to the rumen or reticulum and mix with the ingesta there before passing to the abomasum and intestines, it may be seen that they will be greatly diluted and possibly not in sufficient concentration to materially affect the parasites. In case of the parasites under discussion the larvae of which become encysted in the intestinal wall, it must be remembered that the anthelmintics will act only upon the adult worms in the lumen of the intestines and not upon the larvae in the worm nodules. It is stated, however, that if the mature blood sucking worm can be removed, that in the majority of cases the nodules will not prevent fattening the animals. The animals under treatment should be isolated, food withheld for eighteen to twenty-four hours, and one of the following recommended treatments undertaken: For yearling cattle 1 pint of a 1 per cent solution of coal tar creosote; for calves three to eight months old 5 to 10 ounces; thymol 2 drams in a pint or so of water, or the thymol may be given combined with the creosote; lysol or creolin (Pearson's) for young cattle ½ ounce to a quart of water, and followed at intervals of two or three days by smaller doses; 1 to 2 pounds of magnesium or sodium sulfate followed in a few hours by 2 to 4 ounces of oil of turpentine in milk or raw linseed oil. 1 to 3 ounce doses of gasoline in milk are recommended to follow the salts treatment. Of a 1 per cent solution of copper sulfate, 3 to 4 ounces for calves, 6 to 8 ounces for yearlings, and 12 to 16 ounces for adults are recommended. The doses of course must be varied depending upon the age of the

animals under treatment and repeated if indicated. Equal parts of ferrous sulfate, sodium sulfate, and sodium chloride kept constantly before a herd of infested animals will tend to inhibit the development, and destroy many of the worms.

Oesophagostomum Columbianum: Infests sheep most commonly in the United States, but cattle also to some extent. Mature worms are from three fourths to one inch in length, and infest both the large and small intestines. The larvae produce the characteristic nodules in the intestines thereby giving the condition the name "nodular disease" in sheep. The entire intestinal canal may be studded and the inexperienced may frequently mistake the condition not only in sheep, but in cattle and pigs for tuberculosis. While this form of infestation is not so fatal as that due to the oesophagostoma radiatum yet it causes general debility, anemic condition, with accompanying poor fleece, etc.

The treatment consists in avoiding wet pastures, or changing from suspicious pastures; and the separation of the sick and all adult animals from the young. If possible animals should have access to running water. Infested pastures should be abandoned for two years. The mature worms may be more or less eradicated by treatment such as a mixture of powdered areca 1½ ounces and arsenic 7 grains (for ten adult sheep), mixed with bran and given once daily for a few days. ½ dram to 1½ drams single doses of thymol followed by a saline purge are of value. Solution of copper sulfate, of a 1.25 percent watery solution, 1 tablespoonful for young lambs, 3 tablespoonfuls for lambs one half year old, and 2 to 3 ounces for yearlings and adult sheep are recommended. 2 to 4 drams of gasoline given in 4 ounces of milk, after fasting, followed by proper dosage with salts give good results. 2 to 4 ounces of a 1 percent solution of coal tar creosote for a lamb four to twelve months old, and 3 to 5 ounces for sheep a year old and upwards are recommended. Pearson's creolin or lysol diluted in 4 ounces of milk in doses of ½ dram for lambs over six months of age and 1 dram over one year of age are useful. Arsenic 1 grain, ferrous sulfate 10 grains, given in oats or bran for six days is recommended. The gasoline treatment as recommended for stomach worm infestation in sheep is of value and very generally used. A common mixture used for sheep is:

RX Chloroformi, m. x.
Olei Terebinthinae, ℥. ss. to i.
Creolini, m. x.
Aquae, ℥. ii.
M.

Administer three or four times in two weeks.

Equal parts of ferrous sulfate and sodium chloride to which the sheep have free access will tend to make the intestinal tract unfavorable for the development of the worms.

Oesophagostmum Dentatum: Infests hogs, the parasites being usually found in the caecum and colon. They are from one third to three fourths of an inch long. No detrimental results are noticed in the hogs if only a few parasites are found, but large numbers produce unthriftiness, indigestion, diarrhoea, and often death. The caecal and colon contents are often fairly alive with the parasites. The measures used for eradication are the same as prescribed for the eradication of the ascaris suilla.

INTESTINAL STRONGYLOSIS AND SCLEROSTOMIASIS IN THE HORSE.

The above terms refer to the condition in which the animal is infested by certain of the strongyli or sclerostoma, which are the most serious intestinal parasites infesting horses and mules. Intestinal strongylosis in young horses in Iowa has come to be of very frequent occurrence in the last few years and has caused the death of hundreds of young horses. On account of the small size of the parasite, and the fact that it burrows into the feces as soon as passed and hence disappears from view, has commonly lead to marked errors in diagnosis by the practitioner.

STRONGYLUS VULGARIS: There are three species of strongyli infesting the intestines of horses and mules, the species named above being the one recognized as most commonly invading the blood vessels. It is the larval form of the parasite that gets into the blood vessels, the mature worm inhabiting the lumen of the intestines. The ova are voided with feces, the larvae developing in the outside world particularly in moist places and being reingested with drinking water or feed contaminated with manure, or on infested pastures. The larvae after ingestion bore into the intestinal wall, frequently enter blood vessels and get into the circulation often in such numbers as to cause thrombosis, particularly of the mesenteric vessels resulting in death. The mature worms cause intestinal irritation, diarrhoea, emaciation, and often death particularly in one, two or three year old horses. Adult horses are not so seriously affected. The adult intestinal strongyli being blood suckers vary in color from white to red depending upon the quantity of blood they contain. They vary in length, depending upon the variety, age and sex from one-fourth to two and one-half inches and compare in calibre with various sized sewing needles.

Although as stated there are a number of species of strongyli infesting the intestine the strongylus vulgaris which enters the circulation is usually present. Hence in treating, attempt

must be made in all cases not only to eradicate the mature worms from the intestinal lumen but also the larvae from the circulation. The adult worms which inhabit chiefly the caecum and colon are not only difficult to eradicate, but it is also a certain fact that the larvae in the intestinal wall and in the blood vessels will not be influenced by anthelmintic treatment. Hence along with the treatment to eradicate the mature parasite from the intestinal tract, and which should probably be repeated at intervals inasmuch as the already encysted larvae may pass for sometime from the intestinal wall into the lumen, treatment designated to destroy the larvae in the circulation must also be attempted.

The writer has had opportunity to treat some hundred cases in the last two or three years and observe results of treatment of some two or three hundred other cases. The animals varied from yearlings showing progressive emaciation, anemia, enteritis, diarrhoea, and bordering on collapse, to mature individuals showing no untoward symptoms aside from slight frequent colic and diarrhoea. The drug atoxyl intravenously, together with supplementary treatment has been used in the above mentioned cases, with apparent excellent results. The value of atoxyl which contains from 24.1 to 37.65 percent of arsenic, depending upon the preparation used, in organic combination, has been recognized in human medicine for some time, having been used in trypanosomiasis, spirillosis, etc., where the invading organism is found in large numbers in the circulating fluids of the body, as well as in the primary lesions. The exact manner in which atoxyl acts on the invading organism is not understood. Ehrlich considers the action of the drug to be due to reduction products formed in the system. Levaditi and Yamanonchi seek its action in its combinations with the body albumins. Blumenthal believes the inorganic arsenic which is split off in the system is the active agent and finally its action has been sought in the production of antibodies. It appears reasonable that the inorganic arsenic liberated by the slow decomposition of the atoxyl in the circulation may be the active agent, for there is no question but that inorganic arsenic is destructive to the majority of the lower forms of animal life in the blood as well as in the test tube. The more powerful action of the small quantities of arsenic liberated from atoxyl in the body may perhaps be explained by its being freed slowly over a period of time in the blood, or in the interior of the parasite into which the atoxyl has penetrated. The value of the use of an organic form of arsenic like atoxyl over inorganic arsenic, may be explained by the fact that it can be thrown into the circulation in much larger doses, as it is said to be forty times less toxic than inorganic arsenic, does not unite rapidly with the tissues as does inorganic arsenic, is slowly decomposed,

and yields its products for the destruction of invading organisms over a considerable length of time. It is entirely possible that the toxic, physiological, and remedial properties of the drug are in direct proportion to the amount of arsenic eliminated in the system, and that its only advantages over the older preparations of arsenic are that it may be used subcutaneously or intravenously, and is much less toxic.

In the treatment of intestinal strongylosis atoxyl is generally used intravenously in about 3 percent solution. Small repeated doses may be given, or for convenience sake larger single doses varying from 1 to 3 grams, depending upon the size of the patient. This dose may be repeated in ten days or two weeks. Recent experimental work shows that apparently sodium cacodylate, another organic arsenic preparation may be substituted for atoxyl if necessary with quite favorable results. The doses used are usually a few grains larger, and usually two or possibly three doses are needed a week or ten days apart. At the same time the parasites should be eradicated from the intestinal tract by the use of capsules containing from 1 to 2 drams each, depending upon age of animal, of ferrous sulfate and tartar emetic, one capsule being given for six mornings in succession before feeding, and this six-day treatment preceded and followed by the administration of a small aloes bolus. The same doses of tartar emetic and ferrous sulfate may be given twice daily in the feed if unable to use capsules. It is not the intention to recommend the drug atoxyl as specific in intestinal strongylosis but results based upon its use at the college veterinary hospital and in the field, in the past two years have been quite favorable; it matters not whether the beneficial results were due to the alterative effect of the large amount of arsenic liberated in the system, or to some specificity of the drug in bringing about the destruction of the invading parasites. Followning the treatment, allowing generous diet, possibly tonics, or treatment to allay the intestinal irritation, diarrhoea, etc., the animals showed great improvement, and usually apparently complete recovery. These latter suggestions are very important as frequently the infested animals are extremely debilitated.

Aside from the immediate treatment of the infested animals in an outbreak, prophylactic measures to prevent further ingestion of the larvae are essential. The animals should be kept away from marshy pastures and should not be allowed to drink from pools, etc., where there is a chance of the water being contaminated with feces. Removal of the manure and frequent changes of bedding in and about the quarters of the younger animals should be rigidly practiced, together with the disinfection of the walls and sprinkling of lime, or 5 to 10 percent solutions of chlorinated lime over the floors. Infested animals should be kept

separate from those apparently not infested. The writer has traced infestations with this parasite directly to the pastures upon which the individuals were running, and has prevented infestation in the younger horses on the same premises by keeping them away from the infested animals and off of the pastures known to be infested. Forced nutrition and tonic lines of treatment are usually necessary in animals badly infested with these parasites, following the treatment tending toward eradication.

OXYURIASIS.

Under the genus Oxyuris is found a troublesome parasite infesting horses and mules very commonly, and with which the practitioner frequently meets.

Oxyuris Curvala: Commonly called the pin worm probably on account of the size of the parasite which is from one and one-half to two inches long with a sharp pointed tail by which it adheres to the mucous membrane of the intestine. The parasite is found throughout the large intestine and particularly at the rectal end. They are not blood suckers but cause considerable irritation of this bowel and the rectum which results in a catarrhal state accounting for the dried whitish material found around the anus of infested animals. Considerable itching accompanies the presence of the worms in the region of the rectum, resulting in the animal rubbing the root of the tail, causing the broken and matted appearance of the hair at the tail head. The animal often presents an unthrifty appearance also. Examination of the feces usually shows the presence of the worms in infested animals. Treatment consists largely of rectal injections, as internal administration alone will not give results. Infusions of quassia chips or tobacco 2 to 4 ounces to the gallon of water given in ½ gallon injections for three or four days, and followed with an aloes ball is quite satisfactory. Rectal injections of vinegar and soapy water, along with tartar emetic and ferrous sulfate internally in 1 to 2 dram doses daily for three days and followed with an aloes ball is usually successful. A 5 per cent solution of common salt, or 1 ounce of tincture of ferric chloride to a quart of water, either of the above being injected in 1 quart doses for three or four mornings in succession are efficacious. The feces should always be removed from the rectum by hand before using the vermicide enemata. It is stated that colicky symptoms are frequently due to the presence of these worms, also eczematous conditions, and even phlegmonous conditions of the tail due to the constant rubbing caused by the irritation due to their presence in the rectal region.

STOMACH-WORM OF SHEEP.

Haemonchus Contortus (Strongylus Contortus) is a hair-like worm from one-fourth to three-fourths of an inch in length, and white to pink in color depending upon the amount of blood coloring matter contained, as this parasite is a blood sucker. The abomasum is the principal seat of infestation, where the parasite seems to bore into the gastric mucosa causing either an acute or chronic catarrhal condition of this organ, and even small ulcers, paving the way for bacterial infection. The extent of the disturbance of nutrition in the animal depends upon the number of parasites present. The contents of the abomasum often show a reddish discoloration and frequently the presence of these parasites can only be determined by a microscopical examination of the contents. Inasmuch as the ova of the parasites are passed with the feces, the larvae developing in marshy or wet places outside the body to be reingested with food, water, etc., prophylaxis consists in avoiding wet, marshy, or suspicious pastures if possible, and the separation of all sick animals from the rest of the flock and particularly from the lambs. If a continuous avoidance of the pastures is not possible they should be abandoned for one or two years. The larvae are very resistant, even withstanding freezing or desiccation for several weeks.

Of the many treatments recommended, only three or four have proven particularly efficient, i. e. coal-tar creosote often combined with thymol, copper sulphate, creolin or lysol, and gasoline.

Gasoline: Gasoline has long been used in treatment of stomach worms and is unquestionably efficient. It has a disadvantage, however, in that often two or three doses on successive days are necessary. Food and water should be withheld the night before dosing and until ten o'clock the next day. Three hours after dosing food and water may be given and then no more until after the dosing the second day. This should be kept up for three days. Gasoline, if properly used, is not particularly dangerous altho sudden collapse and once in awhile a death will occur. Aromatic spirits of ammonia should be on hand and if the sheep is suddenly overcome by the gasoline, 1 or 2 teaspoonfuls as a drench may be given and repeated if necessary. Recovery usually follows. Strychnine is used in gasoline collapse in cattle. The proper dosage of gasoline for lambs is 2 drams and for sheep 4 drams, given in 3 or 4 ounces of milk, an infusion of flax seed, or in linseed oil. Care should be taken in administration.

Coal tar creosote, Creolin, Lysol. These coal tar derivatives are highly efficient, a single dose often being sufficient to bring

remarkable results in the affected animals. The Bureau of Animal Industry recommends coal tar creosote in 1 per cent solution in doses as follows:

Lambs four to twelve months old 2 to 4 ounces.

Yearlings and upward 3 to 5 ounces.

As stated above a single dose often gives good results, the animals showing marked improvement in a few days. Experimental work has shown that in sheep killed immediately after this dosage and the abomasum opened, that the parasites were found dead. There are certain objections to the attempted use of so called coal tar creosote, in that it is a very uncertain product in a number of ways. Many reliable firms refuse to put it on the market and trouble is often encountered in securing it. Druggists will always dispense beech wood creosote when creosote is called for and this does not give satisfactory results. It seems as though these difficulties regarding so called coal tar creosote can easily be met by the use of Pearson's creolin which is saponified coal tar creosote, or lysol which contains approximately fifty per cent of cresols. The dose of either is ½ dram for lambs over six months and 1 dram for yearlings and upward, diluted in 4 to 6 ounces of milk or in gruel.

Thymol is highly recommended added to any of the above suggested doses in amounts varying from 20 to 30 grains for lambs, to 45 grains for adult sheep. Thymol is somewhat high in price just at present. Thymol in tablet form and various combinations such as aresenic, creosote, napthalin, and tartar emetic in tablet form, placed in the sheep's mouth and washed down with water have been recommended by certain commercial firms, however the writer is not advised as to their efficacy.

Copper Sulphate: Only clear blue crystals should be used and the solution for drenching should be accurately made by carefully weighing the ingredients. Good results have been reported from this state and from Ohio from the copper sulphate treatment, often a single treatment being followed by improvement inside of a week. The sheep should be fasted for eighteen to twenty-four hours before treating. A 1 per cent solution of copper sulphate is used, the doses of which are as follows: Lambs three to six months of age 6 drams to 1½ ounces; six months to twelve months of age, 1½ to 2½ ounces; one year to two years of age 2½ to 3½ ounces. These doses should be accurately measured, and graduated according to the age of the animals. Water should not be allowed for some time after the treatment. In treating sheep it is always advisable to try out the treatment as to dosage, method of handling, etc. on three or four and note the results before treating the entire flock. Turpentine is not successful in treating for the stomach worm.

TAENIASIS.

The genus taenia (tape worm) contains many different species. one or more of which infest commonly all the various species of domesticated animals. Inasmuch as tape worm infestations more frequently in this State at least, are called to our attention as veterinarians in connection with the sheep and dog, the discussion here will be limited to these species.

Taenia Epansa, Alba and Fimbriata: The first two species inhabit the small intestine of both the ox and sheep. The last species taenia fimbriata, is the most common species of tape worm infesting sheep, its habitat being the small intestine. The life history of the tape worm is somewhat peculiar in that a proper intermediate host is essential for the development to maturity, and for this reason the life history of the tape worm is not as thoroughly understood as for some of the other parasites. The injurious effects of the taenia are due to robbing the host of nutrients, thus in an extensive infestation causing unthrifty condition, this being very noticeable in lambs; also the toxic products produced by the parasite are said to be injurious, and not infrequently worms may enter and occlude the bile duct as do some of the other parasites. The taenia expansa infesting sheep may measure one-half inch wide and twenty to forty feet in length. The taenia alba may measure one-half inch in width and three to seven feet in length. Fatalities due to this parasite are said to run as high as twenty per cent. The fully developed worm of the taenia fimbriata species varies from three to six inches in length.

In treating sheep for tape worms it is advisable to fast the animals for eighteen to twenty-four hours, then give one dram oleoresin of aspidium together with one to three drams of areca nut, this to be followed in three or four hours by four to six ounces of Epsom salts. Thymol one half to two drams followed by three to eight grains of tartar emetic and later by a saline purge usually gives results. Oil of turpentine in one to four dram doses in three or four tablespoonfuls of castor or other oil and repeated is of value. Prophylaxis consists in keeping the sheep especially lambs, away from infested pastures.

There are six species of taenia commonly found in dogs, several species often inhabiting one host. Proper medication usually eradicates the parasites without great difficulty. The animal should be starved for twenty-four hours and the intestines emptied by the use of mild laxatives. In order to prevent vomiting the animal may then be given some milk or mucilaginous soup. A combination of oleoresin of aspidium 15 minims to 1 dram, chloroform 10 minims, followed in three hours by croton

oil 1½ minims, and castor oil one-half ounce is successful in nearly all cases. The dosage must be varied of course depending on the size of the dog. The drug aspidium or male fern is commonly spoken of as a specific for tape worms. Many preparations are dispensed; however, oleoresin is generally used. The oleoresin 15 minims to one dram may be flavored with a few drops of oil of peppermint and combined with areca nut, (1 grain to one pound live weight), in emulsion with acacia or tragacanth and given as one dose followed by castor oil.

STRONGYLOSIS OF THE BRONCHI AND LUNGS.

Lung Worm Disease; Verminous Bronchitis; Verminous Pneumonia: Disease due to various species of strongyli in the lungs or bronchi of the various domesticated animals is a common condition causing many deaths. In this state calves, sheep, and pigs are probably most affected. The affection is usually enzootic but is even epizootic. The bronchial type of the disease is most often found in young animals while the pulmonary form is found in adults. The parasites, ten or twelve species of which have been recognized infesting various animals, are thread-like worms, the species varying from one to ten centimeters in length. The life history of lung worms is only partially known, and in some species entirely unknown. The worms deposit their ova in the air passages, the embryos develop and are expelled into the outside world with the bronchial secretion during coughing, or they get into the pharynx, are swallowed and pass out with the feces. Opinions differ as to the further development of the larvae outside. Wet pastures, moist feed lots, etc., favor the development of the larvae which may be taken up by the animals by inhalation of dust from contaminated areas, or are ingested with the food and by wandering get into the respiratory passages. Young animals which have reached at least the age of several weeks are preferably affected. Older animals usually are affected in proportion to advancing age. Sheep, however, seem to be affected independently of age, the clinical symptoms being much milder the older the animal.

The disease manifests itself usually in all species of animals as an insidious bronchitis, which increases in intensity from week to week and in some cases is accompanied by conditions of pneumonia, which eventually result in death.

The cause of the diseased condition produced by the infestation varies a great deal in species and among animals of the same species. Lung worms may often live in large numbers in hogs without apparently much disturbing the condition of health. Sheep seem to be most seriously affected by an invasion, among cattle, calves often die, and deaths are frequent also among pigs. The course of the affection depends largely upon

the occurrence of secondary infection. The duration of the disease may be two, three, or four months, or it may take a fatal issue within a few weeks in young animals, such as calves. In mild form the disease usually ends in recovery, in cases of medium intensity recovery usually occurs in pigs following logical therapeutic, preventative, and dietetic measures; calves frequently recover, while sheep and goats often die, particularly the younger weaker animals. The more severe forms usually result fatally in all animals. Improvement is marked by gradual diminution of the cough and disappearance of other symptoms. Often animals will show nutritional disturbances which result in death even after apparent recovery, as far as lung symptoms are concerned.

The particular parasites most commonly infesting calves, sheep, and pigs, will be mentioned together with treatment and general methods of prevention.

Strongylus Micrurus: Infests young cattle, especially calves, and up to two and one-half years of age. A cough is first observed, at first strong and not frequent, but later becomes frequent and forced, the tongue being protruded and masses of mucous are expelled often mixed with blood and containing worms. Symptoms of suffocation often appear. Symptoms sometimes increase very rapidly, and death may occur in two weeks but as a rule the cough becomes graduallly weaker, the respirations more labored, and the ingestion of food less. The animal shows a cachectic, anemic condition and edematous swellings may appear.

In treating this condition internal administrations are of value only so far as they destroy the larvae of the parasites taken with the food, and which may later migrate from the intestinal to the respiratory tract. The volatile oils, such as oil of turpentine, which are excreted by the lungs have been used but these drugs are not eliminated by the respiratory tract to the extent that they will destroy parasites. Intratracheal injections of antiparasitic medicines and various sprays have been used with both favorable and unfavorable results. Some observers state that favorable results cannot be attained by these methods, others claim good results. Steaming with iodine, creosote, thymol, etc., or oil of eucalyptus and turpentine, of this latter combination one dram each in one-half gallon of water, have been used with apparently good results in some cases. The steaming should be carried on every other day for several times, the inhalations being given each time until severe coughing is induced. Intratracheal injections or sprays are the most popular methods of combating the parasites in the air passages and seem to give best results. The needle is inserted between two tracheal rings and directed to-

ward the chest. The medicine is slowly injected with the animal's head elevated to prevent the fluid flowing into the larynx; Various preparations are recommended as follows:

RX (1) Phenolis m. x.
Chloroformi ℥. ss.
Olei terebinthinae ℥i.
Glycerini ℥i.
M.

The above prescription constitutes a single dose.

RX (2) Olei olivae ℥i.
Olei terebinthinae ℥x.
Phenolis ℥. iss.
M.

A single dose is 2½ drams.

The medicine is injected intratracheally every third day for three injections.

RX Olei olivae ℥v.
Olei terebinthinae ℥v.
Creolini (Pearson) ℥. ss.
M.

Of the above prescription for calves two injections at an interval of three days, 20 mils (cc) at dose. The above preparations will usually destroy the worms and embryos in the trachae and upper bronchi at least. In order to ensure that the mixture reaches the smallest bronchioles, Schiebel has introduced a method of spraying a mixture into the lungs. A curved trochar and cannula are inserted, the trochar removed, and a V-shaped spraying tube is inserted into the cannula. Rubber tubes are attached to the V tube one blowing in air the other attached to a vessel containing the vermicide mixture. He recommends the following:

RX Creosoti ℥i.
Alcoholis.
M. Aquae aa. ℥. vi.
Dose 2½ to 5 drams.

The vessel is held lower than the cannula to prevent the fluid flowing into the trachea. A pause is made when a fit of coughing ensues. This spraying is carried out daily for three days with reported invariably successful results. The above mixture may be injected intratracheally instead of spraying if desired, but with not as successful results. Full success in any case of course can only be secured when the lungs are not seriously affected.

Strongylus Filaria: Very common in this country and affects sheep and goats. The disease is called hoose, husk, paper disease, and lamb disease. The cough is first observed in a few animals, is short, dry and strong, and spreads gradually to the greater portion of the herd. The bronchial secretion containing worms is expelled in lumps through the mouth. Considerable nasal discharge is noticed and the sheep may rub their noses on the ground until lacerated. Marked disturbances in nutrition are noticed and frequently diarrhoea. The eyelids, lips, head, larynx, and lower thorax may become edematous, and a partial paralysis of the limbs appear.

The treatment is similar to that described for calves, the dosage being one-third to one-fourth that for calves.

Favorable results are reported in both lambs and calves with the intratracheal injection of a 1 per cent solution of carbolic acid, 15 mils (cc) for lambs, 45 mils (cc) for calves.

The following excerpt regarding treatment of lung worm infestation in calves and goats, is taken from an article on "Pulmonary Strongylosis" recently published by Wm. B. Herms and S. B. Freeborn, the experimental work having been carried on at the University of California.

"Treatment: The administration of anthelmintics which may be excreted through the lungs has been widely advocated for many years, but has proved only mildly successful owing to the impossibility of giving a sufficient dose to be effective in the air passage. Placing infested animals in rooms filled with the dust and fumes of air-slaked lime or sulphur has been practiced by many stockmen, removing the animals as soon as they are overcome. This practice usually resulted in saving about half of the animals and killing the other half, but the owners reasoned that it were better to save half of the number treated than to lose all of them by the disease.

It was in the hope of determining an anthelmintic which could be applied directly to the air passages and effect a cure without attendant fatalities that a series of experiments was instituted by the Laboratory of Parasitology at the University of California during the autumn of 1914 and carried on for a period of over a year. Various substances, such as turpentine, benzine, ether, and chlororform were administered singly and in combinations, both intratracheally and nasally. Based on these experiments, involving about 250 animals, both goats and calves, it is believed that chloroform (either chemically pure or commercial) administered nasally in doses sufficient to nearly anaesthetize the animal is a valuable and simple method of treatment.

Experiments have shown that although the worms were not killed immediately, death and disintegration of the majority of the parasites takes place a few hours after treatment, when it

has been observed that large numbers of the worms may be expelled in the act of coughing and swallowed. It is hardly to be expected that one, or for that matter, many treatments would kill all the worms, particularly those located in the deeper collapsed portions of the lungs.

The chloroform is administered nasally (first into one nostril then into the other) by means of an all-glass syringe or a medicine dropper. Chloroform dissolves the lubricant on the piston of the all-metal syringe and destroys the rubber ring of the ordinary veterinary syringe, hence the use of a common medicine dropper.

It is impossible to prescribe an exact dosage for two reasons: (1) animals vary in the amount necessary to anaesthetize them, and (2) the effectiveness of the dose depends on whether the animal at the time of treatment is inhaling or exhaling. With these two factors in mind the authors have consistently hesitated to prescribe an exact dosage, but have recommended that sufficient chloroform be administered to produce "grogginess" with a repetition of the treatment at five or six day intervals until recovery is secured. Where proper care in food and shelter is exercised three injections have been the maximum required in any one case. Dosage varies from one and a half to three cubic centimeters for angora goats and from four to eleven cubic centimeters for calves,—one-half the quantity to each nostril.

Prolonged chloroform anaesthesia is known to produce necrosis of the liver, and for this reason the authors were somewhat hesitant to recommend the above treatment until this complication was shown to be negligible by the absence of fatalities in several hundred cases treated over a period of nearly three years.

It is highly important that infected animals whether under treatment or not should receive sufficient nourishing food easily and be afforded shelter against inclement weather."

Strongylus Paradoxus: Causes lung worm disease in hogs and is very prevalent in this country. In intense invasions it may cause large losses, taking a course similar to that in sheep. Again few deaths occur and the animal shows only nutritional disturbances. The disease predisposes the animals to attacks by other disease such as cholera. Intratracheal injections are not of course practicable in hogs and treatment is largely prophylactic, and keeping the intestines free from the other parasites usually present along with the lung worm. Equal parts of ferrous sulfate, sulphur, and Epsom salts kept constantly before the animals will tend to inhibit parasitic infestation and exert a tonic effect; also forced nutrition must be practiced when the animals are infested. Kerosene, various volatile oils, etc., often used internally supposed to exert action in the lungs during their elimination are of questionable value. Prophylaxis is the very

important item in lung worm infestations. Low situated, damp feed yards, and marshy pastures should be avoided.

Animals should not be allowed to drink from pools in the pastures. In an infested herd, young animals should be separated from the adults, and all sick animals from the healthy. Very sick animals had better be destroyed. Yards, sheds, drinking places, etc., should be disinfected and all litter contaminated by sputum, feces, etc., destroyed. Old sheds difficult to clean and keep sanitary had better be abandoned, and lots changed if at all feasible. Wet lots should be scrupulously avoided.

PHTHIRIASIS.

Phthiriasis refers to the condition of an animal infested with lice. Among the domesticated animals several varieties of blood sucking lice belonging to the genus Hematopinus occur, and also several varieties of hair lice belonging to the genus Trichodectes. The lice are oviparous, the females gluing their oval shaped eggs, which are commonly called "nits," to the hair. They multiply very rapidly, and particularly during the winter and spring months due to the closer stabling of animals during these months, and also the long-haired condition of the animals which forms a protection for the parasites. Lousiness may cause conditions varying from mere restlessness of the animals due to the itching produced, to even death in young animals, pigs for example, due to unrest, disturbance of sucking, and loss of blood. Itching causing rubbing and biting at the skin, stairy, matted hair, decline in condition, and often eczematous inflammation of the skin are associated with the infestation.

Treatment consists in a thorough cleaning and disinfection of all quarters, stalls, mangers, blankets, curry combs, etc., with which the animals have come in contact, and eradication of the lice and nits from the infested animals. In severe infestations the worst affected individuals should be isolated if possible. Clipping the hair, which should be burned, in young horses in the spring will facilitate the destruction of the parasites. Lice may be destroyed by a number of anti-parasitic remedies. In any animals washing with a 2 to 3 per cent solution of common coal tar disinfectants such as creolin, lysol, etc., has a good effect; however it must be repeated several times. A 15 per cent solution of denatured alcohol in 2 per cent creolin solution is in the opinion of the writer very efficacious, and has given excellent results in the college veterinary hospital, one treatment often sufficing. Quassia chips, or tobacco stems 4 ounces to a gallon of water and boiled for thirty minutes give good results, the decoction being applied with a sponge. For pigs a kerosene emulsion sprayed upon the animals by means of a spray gun or sprinkling can gives good results. This emulsion should be made as

follows: Kerosene 2 gallons; common soap 8 ounces; water 1 gallon. Dissolve the soap in boiling water; add the boiling soap mixture to the kerosene, stirring for ten minutes. When used, one part of this emulsion should be added to nine parts of water. A creolin liniment, made and used as follows, but which is not applicable in all cases gives excellent results. (Creolin and green soap of each 1 part, denatured alcohol 7 parts); one third of the body is treated at a time for three days and after the third day the body is bathed in a ½ to 1 per cent sulphur mixture.

Pyrethrum, also called Persian, Caucasian, or Dalmatian insect powder, and which is probably one of the active ingredients of commercial louse powders may be dusted over the surface of the skin, or applied in the form of a tincture (1-4) diluted with 10 parts of water. Yellow ochre is commonly used as a dilutant for pyrethrum, and naphthalin, the pyrethrum content being about 30 per cent and the naphthalin content 5 per cent. This gives good results when simply dusted into the hair, or is commonly used as a louse powder for chickens. Where the nits hang tightly to the hair, washing with vinegar will facilitate their removal.

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